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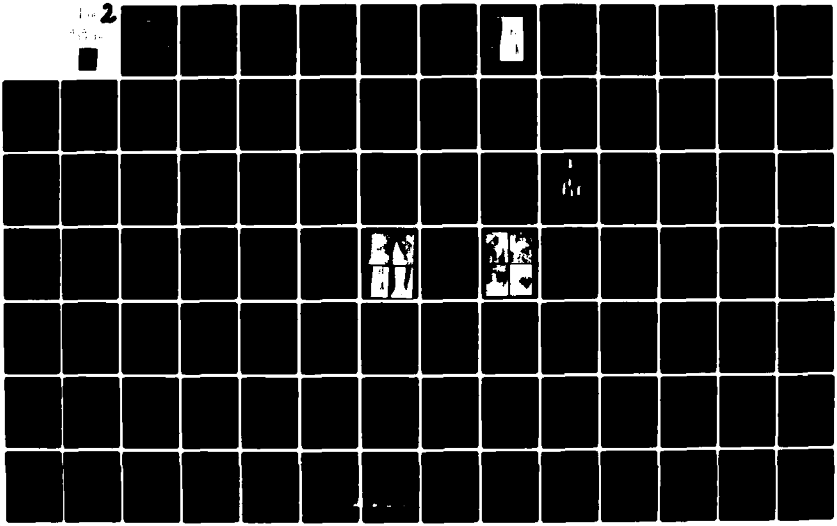

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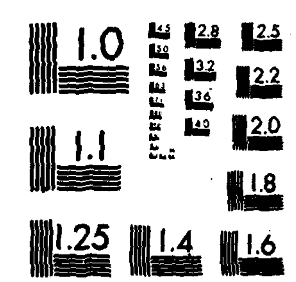

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RED RUN, FRANKLIN COUNTY

(6) National Dam Inspection Program. [redacted]

WOHELO LAKE DAM

(**NDI I.D.** [redacted] Number **PA-00326**,
PENNDER I.D. [redacted] **28-95**), Number
Potomac River Basin, Red Run, Franklin County
~~DNC~~
Pennsylvania.

PHASE I INSPECTION REPORT,
NATIONAL DAM INSPECTION PROGRAM

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PREPARED FOR

(10) Bernard M. Mihalcin

DEPARTMENT OF THE ARMY
Baltimore District, Corps of Engineers
Baltimore, Maryland 21203

PREPARED BY

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"Original contains color plates: All DTIC reproductions will be in black and white"

GAI CONSULTANTS, INC.
570 BEATTY ROAD
MONROEVILLE, PENNSYLVANIA 15146

(11) **AUG** ~~**UST 1980**~~

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DISCLAIMER NOTICE

PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D. C. 20314. The purpose of a Phase I investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation and analyses involving topograhic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through frequent inspections can unsafe conditions be detected and only through continued care and maintenance can these conditions be prevented or corrected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established guidelines, the spillway design flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. The spillway design flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition, and the downstream damage potential.

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

ABSTRACT

Wohelo Lake Dam: NDI I.D. No. PA-00326

<u>Owner</u>:	Wohelo Realty Company
<u>State Located</u>:	Pennsylvania (PennDER I.D. No. 28-95)
<u>County Located</u>:	Franklin
<u>Stream</u>:	Red Run
<u>Inspection Date</u>:	26 June 1980
<u>Inspection Team</u>:	GAI Consultants, Inc. 570 Beatty Road Monroeville, Pennsylvania 15146

Based on a visual inspection, operational history, and hydrologic/hydraulic analysis, the dam is considered to be in good condition.

The size classification of the facility is small and the hazard classification is considered to be high. In accordance with the recommended guidelines, the Spillway Design Flood (SDF) ranges between the 1/2-PMF (Probable Maximum Flood) and the PMF. Due to the high potential for damage to downstream structures and possible loss of life, the SDF is considered to be the PMF. Results of the hydrologic and hydraulic analysis indicate the facility will pass and/or store approximately 43 percent of the PMF prior to embankment overtopping at the low top of the dam. Breach analysis indicates that failure under a 0.45 PMF event or larger would probably not lead to increased property damage or loss of life at existing residences. Thus, based on the screening criteria contained in the recommended guidelines, the spillway is deemed inadequate, but not seriously inadequate. If the embankment crest were regraded and restored to its design elevation, the facility would pass and/or store approximately 51 percent of the PMF prior to embankment overtopping, but would still be considered inadequate.

It is noted, also, that the analysis indicates that flooding of downstream structures could occur from non-breach outflow

of a storm on the order of 1/2-PMF magnitude.

It is recommended that the owner immediately:

a. Regrade the crest of the embankment to its original design elevation under the direction of a registered professional engineer experienced in the construction of earth dams, or retain the services of a registered professional engineer experienced in the hydraulics and hydrology of dams to further assess the adequacy of the spillway facilities and take remedial measures deemed necessary to make the facility hydraulically adequate.

b. Retain the services of a registered professional engineer experienced in the design and construction of earth embankments to evaluate the source of seepage and/or leakage observed just below the discharge ends of the outlet conduits. This condition should be assessed in all future inspections with any turbidity and/or changes in flow rate specifically noted.

c. Restore access and operability to the outlet control mechanisms.

d. Remove the large trees from along the downstream embankment toe and clear the brush covering the embankment slopes.

e. Clear the brush that partially obstructs the right side of the spillway channel at the crest.

f. Develop formal manuals of operations and maintenance to ensure future proper care of the facility. In light of the unusually steep upstream embankment slope, special procedures should be incorporated into these manuals that provide for the emergency drawdown of the reservoir under the direction of a registered professional engineer experienced in the design and construction earth dams.

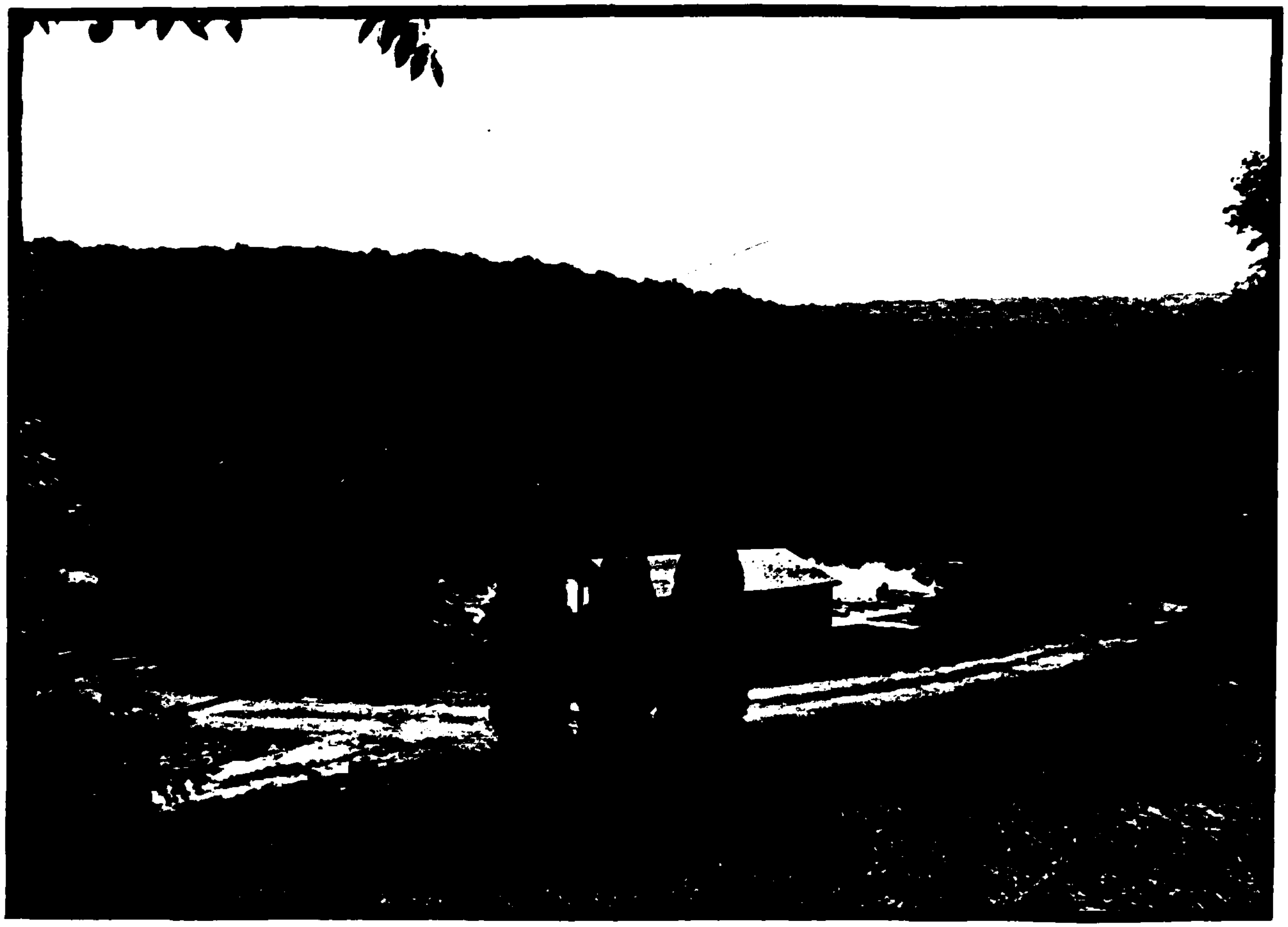
A23

g. Develop a formal emergency warning system to notify downstream residents should hazardous conditions develop. Included in the plan should be provisions for around-the-clock surveillance of the facility during periods of unusually heavy precipitation.

GAI Consultants, Inc.	Approved by:
Bernard M. Mihalcin, P.E.	JAMES W. PECK Colonel, Corps of Engineers District Engineer

COMMONWEALTH OF PENNSYLVANIA
REGISTERED PROFESSIONAL
BERNARD M. MIHALCIN
ENGINEER
20371-E

Date 28 August 80	Date 12 Sep 80



OVERVIEW PHOTOGRAPH

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PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM
WOHELO LAKE DAM
NDI# PA-00326, PENNDER# 28-95

SECTION 1
GENERAL INFORMATION

1.1 Authority.

The Dam Inspection Act, Public Law 92-367, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of inspection of dams throughout the United States.

1.1 Purpose.

The purpose is to determine if the dam constitutes a hazard to human life or property.

1.2 Description of Project.

a. Dam and Appurtenances. Wohelo Lake Dam is a zoned earth embankment approximately 28 feet high and 560 feet long, including spillway. The facility is provided with an uncontrolled, trapezoidal shaped, concrete lined chute channel spillway located at the right abutment. The outlet works consists of two 24-inch diameter corrugated metal pipes (CMPs) encased in concrete that discharge at the downstream embankment toe. Flow through the conduits is reportedly controlled at the inlets situated along the upstream embankment toe by means of two 24-inch diameter gate valves.

b. Location. Wohelo Lake Dam is located on Red Run in Washington Township, Franklin County, Pennsylvania about four miles southeast of Waynesboro, Pennsylvania. The facility is part of Camp Wohelo, a summer recreational camp. The dam and reservoir are contained within the Smithsburg, Maryland - Pennsylvania 7.5 minute U.S.G.S. topographic quadrangle (see Figure 1, Appendix E). The coordinates of the dam are N39°44.3' and W77°30.4'.

c. Size Classification. Small (28 feet high, 85 acre-feet storage capacity at top of dam).

d. Hazard Classification. High (see Section 3.1.e).

e. Ownership. Wohelo Realty Company
12811 Old Route 16
Waynesboro, Pennsylvania 17268
Attn: Morgan I. Levy

f. Purpose. Recreation.

g. Historical Data. Wohelo Lake Dam was designed by A. M. Larsen of McConnellsburg, Pennsylvania and constructed by 1953 by E. D. Plummer and Sons of Chambersburg, Pennsylvania. No correspondence is available from PennDER files for this facility and historical data are limited to file drawings. Four of the drawings (dated May 1952, Figures 3 through 6 in Appendix E) apparently represent the original design whereas Figure 2 (dated September 1953) shows the as-built plan for the completed facility.

Comparison of these drawings with field observed conditions indicates that significant design changes were made to the facility during construction which resulted in steeper slopes, a narrower crest and the installation of valve mechanisms on the outlet conduits.

Two or three years ago the access bridge to the outlet control mechanisms was burned by vandals during the off season when the camp was inactive. The bridge was never rebuilt nor were the damaged outlet conduit control mechanisms repaired. The owner now has a full-time, year-round, maintenance staff, in an effort to control vandalism.

Some renovation work was completed just prior to the inspection during which a substantial portion of the spillway discharge channel was lined with concrete.

1.3 Pertinent Data.

a. Drainage Area (square miles). 4.0

b. Discharge at Dam Site.

Discharge Capacity of Outlet Conduits - Discharge curves are not available.

Discharge Capacity of Spillway at Maximum Pool ≅ 4310 cfs (see Appendix D, Sheet 9).

c. Elevation (feet above mean sea level). The following elevations were obtained from available drawings and through field measurements based on the elevation of the spillway crest at 970.0 feet (see Appendix D, Sheet 1).

Top of Dam	981.5 (design). 980.3 (field).
Maximum Design Pool	Not known.
Maximum Pool of Record	972 (June 1972).
Normal Pool	970.0
Spillway Crest	970.0
Upstream Inlet Invert	955 (estimate).
Downstream Outlet Invert	952.3 (field).
Streambed at Dam Centerline	954 (estimate).
Maximum Tailwater	Not known.

d. Reservoir Length (feet).

Top of Dam	1200
Normal Pool	300

e. Storage (acre-feet).

Top of Dam	85
Normal Pool	22

f. Reservoir Surface (acres).

Top of Dam	9
Normal Pool	4

g. Dam.

Type	Zoned earth.
Length	522 feet (excluding spillway).
Height	28 feet (field measured; crest to downstream outlet invert).
Top Width	10 feet (design). 6 feet (field).
Upstream Slope	2H:1v (design). 1.25H:1V (field).

	Downstream Slope	2H:1V (design). 1.75H:1V (field).
	Zoning	Impervious clay core covered by outer shells composed of semi-pervious material.
	Impervious Core	Central clay core carried full height of dam with 1H:1V side slopes (see Figure 5).
	Cutoff	10-foot wide trench with 1H:1V side slopes back-filled with impervious material.
	Grout Curtain	None indicated.
h.	<u>Diversion Canal and Regulating Tunnels</u>.	None.
i.	<u>Spillway</u>.	
	Type	Uncontrolled, trapezoidal shaped, concrete lined chute channel.
	Crest Elevation	970.0 feet.
	Crest Length	37.5 feet.
j.	<u>Outlet Conduits</u>.	
	Type	Two 24-inch diameter CMPs encased in concrete.
	Length	210 feet.

Closure and Regulating Facilities	Two 24-inch diameter gate valves located at the conduit inlets.
Access	The original access bridge was burned several years ago and has not been replaced.

SECTION 2
ENGINEERING DATA

2.1 Design.

a. Design Data Availability and Sources. No design reports, calculations, or formal design data are available. Information contained in PennDER files is limited to four design drawings, dated 1952, and one as-built drawing, dated 1953 (see Appendix E, Figures 2, 3, 4, 5, and 6).

b. Design Features.

1. Embankment. Based on information contained in PennDER files and observations made during the visual inspection, general statements can be made regarding the embankment design. The dam is a zoned earth structure constructed with a central core composed of impervious clay material. The core is covered on both sides by semi-pervious materials which comprise the outer embankment shells. The entire upstream slope is protected with a 2-foot thick layer of dumped riprap (see Figure 5).

The design cross section shown in Figure 5 has been significantly altered in that the crest width now measures six feet while the upstream and downstream slopes are set at 1.25H:1V and 1.75H:1V, respectively. Discussions with the owner indicated that modifications to the embankment were required as a result of a decision to decrease the designed spillway width. Also subsequent to project completion, a small concrete apron was placed along a portion of the upstream embankment face reportedly to control seepage. However, it appears that its purpose is to provide support for the access bridge (see Figure 2).

2. Appurtenant Structures.

a) Spillway. The spillway is an uncontrolled, trapezoidal shaped, concrete lined chute channel located at the right abutment. Large flows are discharged through the channel unregulated, whereas, low flows are regulated by a small, triangular shaped weir crest. The length of the spillway crest measures 37.5 feet.

b) Outlet Conduits. The outlet conduits consist of two 24-inch diameter CMPs that are reportedly controlled by 24-inch diameter gate valves at the inlets. Available drawings indicate the conduits are encased in concrete (see Figure 4).

c. Specific Design Data and Criteria. No design data or information relative to design procedures are available.

2.2 Construction Records.

No construction records are available for this facility.

2.3 Operational Records.

No records of the day-to-day operation of this facility are available.

2.4 Other Investigations.

No formal investigations have been performed on this facility subsequent to its construction.

2.5 Evaluation.

The available data are limited to one as-built and four design drawings. Coupled with the visual inspection the data are considered adequate to make a reasonable Phase I assessment of the facility.

SECTION 3
VISUAL INSPECTION

3.1 Observations.

a. General. The general appearance of the facility suggests it to be in good condition.

b. Embankment. Observations made during the visual inspection indicate the embankment is in good condition. No evidence of sloughing, erosion, seepage through the embankment face, excessive settlement or animal burrows were observed. Both slopes are overgrown with high brush that the owner reportedly cuts yearly (see Photographs 1, 2, 3, and 4). A row of evergreen trees along the downstream embankment toe are 25 to 30 feet high and obscure the overall view of the downstream slope. An area of leakage or seepage is evident just beyond the discharge ends of the outlet conduits. Approximately two to three gallons per minute (gpm) of flow is apparent; however, the source has been obscured by recent grading performed in conjunction with spillway discharge channel repairs. The upstream slope is unusually steep (field measured 1.25H:1V) although no signs of instability are present. Reportedly this condition is the result of the embankment height being raised during construction. Consequently, both embankment slopes as well as the crest width vary significantly from those shown on the design drawings (see Figure 5 and Section 1.3.g).

c. Appurtenant Structures.

1. Spillway. The spillway channel was partially lined with concrete just prior to the inspection and appears to be in good condition. Some brush has grown outward into the channel along the spillway crest, partially obstructing the channel (see Photographs 5, 6 and 7).

2. Outlet Conduits. The outlet conduits were not operated in the presence of the inspection team. Furthermore, based on the observed condition of the valve control mechanisms, their operability is questionable. The owner stated that the valves can be operated with a pipe wrench; however, the valve stem(s), marked by a buoy several feet below normal pool, do not appear easily accessible.

d. Reservoir Area. The general area surrounding the reservoir is comprised of steep, heavily forested slopes. No signs of slopes distress were observed.

e. Downstream Channel. Discharge from Wohelo Lake Dam flows through a steep, narrow and heavily forested valley, generally westward out of the Blue Ridge Mountains and into the floodplain just east of Waynesboro, Pennsylvania. Between the toe of Mount Dunlop (see Figure 1, Appendix E) and the western edge of the village of Rouzerville, Pennsylvania, about one to two miles downstream of the embankment, at least a dozen homes and small businesses are situated sufficiently near the stream to possibly be affected by an embankment breach. It is estimated that more than a few lives could be lost and substantial economic damage incurred in this area as a result of such an event. It is noted that many more persons could be affected who live within the Red Run floodplain beyond Rouzerville and along the banks of the east branch of Antietam Creek. Consequently, the hazard classification is considered to be high.

3.2 Evaluation.

The overall condition of the facility is considered to be good. Deficiencies requiring remedial attention include: 1) restoring access and operation to the outlet control mechanisms; 2) locating and observing the source of seepage and/or leakage just beyond the discharge ends of the outlet conduits; 3) clearing brush from the embankment slopes and removing the large trees along the downstream embankment toe; and 4) clearing excess brush from the spillway control section.

SECTION 4
OPERATIONAL PROCEDURES

4.1 Normal Operating Procedure.

The facility is essentially self-regulating. That is, excess inflow discharges automatically over the spillway and is directed downstream. The outlet conduits are presently closed and appear to be inoperable. No formal operations manual is available.

4.2 Maintenance of Dam.

No formal maintenance program exists at this facility. Routine maintenance is performed on an unscheduled basis by the regular maintenance staff. The owner, in the past, has subcontracted out major projects such as the recent spillway renovation. No formal maintenance manual is available.

4.3 Maintenance of Operating Facilities.

See Section 4.2 above.

4.4 Warning System.

No formal warning system is presently in effect. The owner has established a radio communications system between Camps Comet and Wohelo, which was reportedly utilized during the last major flood in June 1972, to maintain contact with observers stationed at the dam and with police and local authorities in downstream communities.

4.5 Evaluation.

No formal operations or maintenance manuals are available for the facility, but, are recommended to ensure the proper care and operation of the facility. In addition, warning system procedures should be formalized and incorporated into these manuals.

SECTION 5
HYDROLOGIC/HYDRAULIC EVALUATION

5.1 Design Data.

No formal design data, calculations, or reports are available.

5.2 Experience Data.

Daily records of spillway and/or outlet conduit discharges are not available. The owner recalled that the largest flood experienced at the facility occurred in June 1972 when the reservoir level rose to the first floor elevation of the boat house situated along the left reservoir shore. This corresponds to approximate elevation 972.0 feet or about 1.9 feet above normal pool.

5.3 Visual Observations.

On the date of the inspection, no conditions were observed that would indicate the spillway could not perform satisfactorily during a flood event within the limits of its design capacity.

5.4 Method of Analysis.

The facility has been analyzed in accordance with the procedures and guidelines established by the U.S. Army, Corps of Engineers, Baltimore District, for Phase I hydrologic and hydraulic evaluations. The analysis has been performed utilizing a modified version of the HEC-1 program developed by the U.S. Army, Corps of Engineers, Hydrologic Engineering Center, Davis, California. Analytical capabilities of the program are briefly outlined in the preface contained in Appendix D.

5.5 Summary of Analysis.

a. Spillway Design Flood (SDF). In accordance with procedures and guidelines contained in the National Guidelines for Safety Inspection of Dams for Phase I Investigations, the Spillway Design Flood (SDF) for Wohelo Lake Dam ranges between the 1/2-PMF (Probable Maximum Flood) and the PMF. This classification is based on the relative size of

the dam (small), and the potential hazard of dam failure to downstream developments (high). Due to high potential for damage to downstream structures and possibly loss of life, the SDF for this facility is considered to be the PMF.

b. Results of Analysis. Wohelo Lake Dam was evaluated under normal operating conditions. That is, the reservoir was initially at its normal pool or spillway elevation of approximately 970.0 feet, with the spillway channel discharging freely. The outlet conduits were assumed to be non-functional for the purpose of analysis, since the flow capacity of these conduits are not such that they would significantly increase the total discharge capabilities of the dam and reservoir. The spillway , situated at the right abutment, consists of a concrete lined channel cut in rock. All pertinent engineering calculations relative to the evaluation of this facility are provided in Appendix D.

Overtopping analysis (using the modified HEC-1 computer program) indicated that the discharge/storage capacity of Wohelo Lake Dam can accommodate only about 43 percent of the PMF (SDF) prior to embankment overtopping. Under PMF conditions, the low top of dam was inundated for about 5.7 hours, by depths of up to 2.9 feet. Under 1/2-PMF conditions, the dam was overtopped for about 2.2 hours, with a maximum depth of about 1.0 foot (Appendix D, Summary Input/Output Sheets, Sheet E). Since the SDF for Wohelo Lake Dam is the PMF, it can be concluded that the dam has a high potential for overtopping, and thus, for breaching under floods of less than SDF magnitude.

As Wohelo Lake Dam cannot safely accommodate a flood of at least 1/2-PMF magnitude, the possiblity of embankment failure under floods of less that 1/2-PMF intensity was investigated (in accordance with Corps directive ETL-1110-2-234). Several possible alternatives were examined, since it is difficult, if not impossible, to determine exactly how or if a specific dam will fail. The major concern of the breaching analysis is with the impact of the various breach discharges on increasing downstream water surface elevations above those to be expected if breaching did not occur.

The modified HEC-1 Computer Program was used for the breaching analysis, with the assumption that the breaching of an earth dam would begin once the reservoir level reached the low top of dam elevation. Also, in routing the outflows downstream, the channel bed was assumed to be initially dry.

Five breach models were analyzed for Wohelo Lake Dam.

First, two sets of breach geometry were evaluated for each of two failure times. The two sets of breach sections chosen were considered to be the minimum and maximum probable failure sections. The two failure times (total time for each breach section to reach its final dimensions) under which the two breach sections were investigated were assumed to be a rapid time (0.5 hours) and a prolonged time (4.0 hours), so that a range of this most sensitive variable might be examined. In addition, an average possible set of breach conditions was analyzed, with a failure time of 2.0 hours (Appendix D, Sheet 14).

The peak breach outflows (resulting from 0.45 PMF conditions) ranged from about 4570 cfs for the minimum section-maximum failure time scheme to about 8120 cfs for the maximum section-minimum fail time scheme (Appendix D, Sheet 16). The peak outflow resulting from the average breach scheme was about 5310 cfs, compared to the non-breach 0.45 PMF peak outflow of approximately 4530 cfs (Summary Input/Output Sheets, Sheet L and E).

Two potential centers of damage were investigated in the analysis. At Section 3 (see Figure 1), located approximately 6660 feet downstream from the dam, all breach outflows remained well below the damage level of the nearby residence. A second potential damage center is located at Section 4 (see Figure 1), located about 2.0 miles downstream from Wohelo Lake Dam. At this section, the non-breach 0.45 PMF event resulted in a peak water surface elevation of about 3.3 feet above the damage level of the nearby homes. The increases in water surface elevation at this section resulting from the various breach models ranged from 0.0 to only about 0.7 feet above the non-breach level (Appendix D, Sheet 17). Since the increase in water surface elevation due to breaching is small in comparison to the expected non-breach flood level, it is concluded that the failure of Wohelo Lake Dam would most likely not lead to increased property damage or loss of life in the downstream regions, as they exist at present.

5.6 Spillway Adequacy.

As presented previously, Wohelo Lake Dam can accommodate only about 43 percent of the PMF (SDF) prior to embankment overtopping. Should a 0.45 PMF or larger event occur, the dam would be overtopped and could possibly fail. Since the failure of Wohelo Lake Dam would probably not lead to increased property damage or loss of life at existing residences, its spillway is considered inadequate, but not seriously inadequate.

SECTION 6
EVALUATION OF STRUCTURAL INTEGRITY

6.1 Visual Observations.

a. Embankment. Visual observations indicate the embankment is in good structural condition. The small flow observed downstream of the outlets is considered minor at present, but nevertheless, its source should be located and the condition addressed in all future inspections. Specifically, turbidity and changes in flow rate should be noted and recorded. The large trees along the downstream toe obscure the overall view of much of the embankment. A clear view of the downstream embankment toe is especially critical during periods of high pool levels when stresses within the embankment and the potential for seepage and piping are increased. Both embankment slopes were found to be steeper than designed, particularly the upstream slope which was measured at 1.25H:1V. No slope distress was observed; however, the most critical stress condition imposed on an upstream slope may occur when the reservoir is lowered. When the outlets are made operable and it is desired to lower or drain the reservoir, particular care should be taken to drawdown the pool at a sufficiently slow rate to maintain stability of the upstream slope.

b. Appurtenant Structures.

1. Spillway. The recently renovated spillway appears to be structurally sound and in good condition. No significant structural deficiencies were observed.

2. Outlet Conduits. The outlet conduits currently appear to be inoperable. This condition has apparently existed for several years ever since the access bridge was destroyed by fire, damaging the gate control mechanisms. A reliable drawdown mechanism is critical to the safe operation of a water impounding facility and, thus, it is recommended that the operability of the outlets be restored.

6.2 Design and Construction Techniques.

No information is available that details the methods of design and/or construction.

6.3 Past Performance.

According to the owner, the facility has functioned adequately since its completion in 1953.

6.4 Seismic Stability.

The dam is located within Seismic Zone No. 1 and may be subject to minor earthquake induced dynamic forces. As the facility appears sufficiently stable, it is believed that it can withstand the expected dynamic forces; however, no calculations and/or investigations were performed to confirm this opinion.

SECTION 7
ASSESSMENT AND RECOMMENDATIONS FOR REMEDIAL MEASURES

7.1 Dam Assessment.

a. Safety. The results of this evaluation indicate the facility is in good condition.

The size classification of the facility is small and its hazard classification is considered to be high. In accordance with the recommended guidelines, the Spillway Design Flood (SDF) for the facility ranges between the 1/2-PMF (Probable Maximum Flood) and the PMF. Due to the high potential for damage to downstream structures and possible loss of life, the SDF is considered to be the PMF. Results of the hydrologic and hydraulic analysis indicate the facility will pass and/or store approximately 43 percent of the PMF prior to embankment overtopping at the low top of dam. Breach analysis indicated that failure under a 0.45 PMF event or larger would probably not lead to increased property damage or loss of life at existing residences. Thus, based on the screening criteria contained in the recommended guidelines, the spillway is deemed inadequate, but not seriously inadequate. If the embankment crest were regraded and restored to its design elevation, the facility would pass and/ or store approximately 51 percent of the PMF prior to embankment overtopping but, would still be considered inadequate.

It is noted, also, that the analysis indicates that flooding of downstream structures could occur from non-breach outflow of a storm on the order of 1/2-PMF magnitude.

b. Adequacy of Information. The available data are considered sufficient to make a reasonable Phase I assessment of the facility.

c. Urgency. The following recommendations should be implemented immediately.

d. Necessity for Additional Investigations. Additional studies are recommended and are listed in Section 7.2.

7.2 Recommendations/Remedial Measures.

It is recommended that the owner immediately:

a. Regrade the crest of the embankment to its original design elevation under the direction of a registered professional engineer experienced in the construction of earth dams, or, retain the services of a registered professional engineer experienced in the hydraulics and hydrology of dams to further assess the adequacy of the spillway facilities and take remedial measures deemed necessary to make the facility hydraulically adequate.

b. Retain the services of a registered professional engineer experienced in the design and construction of earth embankments to evaluate the source of seepage and/or leakage observed just below the discharge ends of the outlet conduits. This condition should be assessed in all future inspections with any turbidity and/or changes in flow rate specifically noted.

c. Restore access and operability to the outlet control mechanisms.

d. Remove the large trees from along the downstream embankment toe and clear the brush covering the embankment slopes.

e. Clear the brush that partially obstructs the right side of the spillway channel at the crest.

f. Develop formal manuals of operations and maintenance to ensure future proper care of the facility. In light of the unusually steep upstream embankment slope, special procedures should be incorporated into these manuals that provide for the emergency drawdown of the reservoir under the direction of a registered professional engineer experienced in the design and construction earth dams.

g. Develop a formal emergency warning system to notify downstream residents should hazardous conditions develop. Included in the plan should be provisions for around-the-clock surveillance of the facility during periods of unusually heavy precipitation.

APPENDIX A

VISUAL INSPECTION CHECKLIST AND FIELD SKETCHES

CHECK LIST
VISUAL INSPECTION
PHASE 1

NAME OF DAM Wohelo Lake Dam STATE Pennsylvania COUNTY Franklin

NDI # PA — 00326 PENNDER # 28-95

TYPE OF DAM Earth SIZE Small HAZARD CATEGORY High

DATE(S) INSPECTION 25 June 1980 WEATHER Sunny and Hot TEMPERATURE 75° @ 10:00 a.m.

POOL ELEVATION AT TIME OF INSPECTION 970.2 feet M.S.L.

TAILWATER AT TIME OF INSPECTION ______ M.S.L.

INSPECTION PERSONNEL	OWNER REPRESENTATIVES	OTHERS
B. M. Mihalcin	Morgan Levy	
D. J. Spaeder		
D. L. Bonk		

RECORDED BY B. M. Milalcin

EMBANKMENT

ITEM	OBSERVATIONS/REMARKS/RECOMMENDATIONS NDI# PA - 00326
SURFACE CRACKS	None observed.
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	None observed.
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	None observed. Upstream embankment slope is visibly steeper than shown on available drawings.
VERTICAL AND HORIZONTAL ALIGNMENT OF THE CREST	Horizontal - good. Vertical - good. Lowest area at left spillway wingwall (see "Profile of Dam Crest", Appendix A).
RIPRAP FAILURES	None observed. Riprap is hard, durable, well-graded sandstone. Extends to top of dam. Slope relatively steep, but appears stable.
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	Good condition. No erosion observed.

EMBANKMENT

ITEM	OBSERVATIONS/REMARKS/RECOMMENDATIONS NDI# PA. 00326
DAMP AREAS IRREGULAR VEGETATION (LUSH OR DEAD PLANTS)	None observed.
ANY NOTICEABLE SEEPAGE	None through embankment. Approximately 2-3 gpm seepage arrarent about 10 feet downstream of outlet conduit headwall. Area recently graded and source of seepage obscured. Should regrade and identify source.
STAFF GAGE AND RECORDER	None.
DRAINS	None observed.

OUTLET WORKS

ITEM	OBSERVATIONS/REMARKS/RECOMMENDATIONS NDI# PA- 00326
INTAKE STRUCTURE	Submerged. Observation from canoe revealed no discernible control mechanism that could be operated to drawdown the reservoir. A marker float is tied to something below the water surface, reportedly the gate stem.
OUTLET CONDUIT (CRACKING AND SPALLING OF CONCRETE SURFACES)	Two 24-inch diameter CMPs encased in concrete. Visible portion in good condition; however, both pipes partially filled with sediment and debris.
OUTLET STRUCTURE	None.
OUTLET CHANNEL	Rock lined (partially mortared), trapezoidal channel extends about 25 feet to where spillway enters channel on right. Unobstructed; recently graded.
GATE(S) AND OPERATIONAL EQUIPMENT	None observed. Buoy in water reportedly to mark gate stem. Owner reports outlet is operable with a pipe wrench.
MISCELLANEOUS	Seepage and orange algae or sediment evident about 10 feet downstream of outlet conduit headwall. Source not discernible. May be through or under conduit or from a toe drain not indicated in available drawings.

EMERGENCY SPILLWAY

ITEM	OBSERVATIONS/REMARKS/RECOMMENDATIONS NDI# PA - 00326
TYPE AND CONDITION	Uncontrolled, trapezoidal shaped, concrete and mortar rock lined, chute channel in good condition. Flow controlled by small triangular shaped weir crest.
APPROACH CHANNEL	Concrete lined - unobstructed except for shrub growth along right abutment slope.
SPILLWAY CHANNEL AND SIDEWALLS	250-foot long, unformed concrete/rock/mortar lined trapezoidal channel-excellent condition.
STILLING BASIN PLUNGE POOL	None.
DISCHARGE CHANNEL	Rock and mortar (unformed concrete) lined channel to confluence with outlet channel - good condition; unobstructed, natural stream.
BRIDGE AND PIERS EMERGENCY GATES	None.

SERVICE SPILLWAY

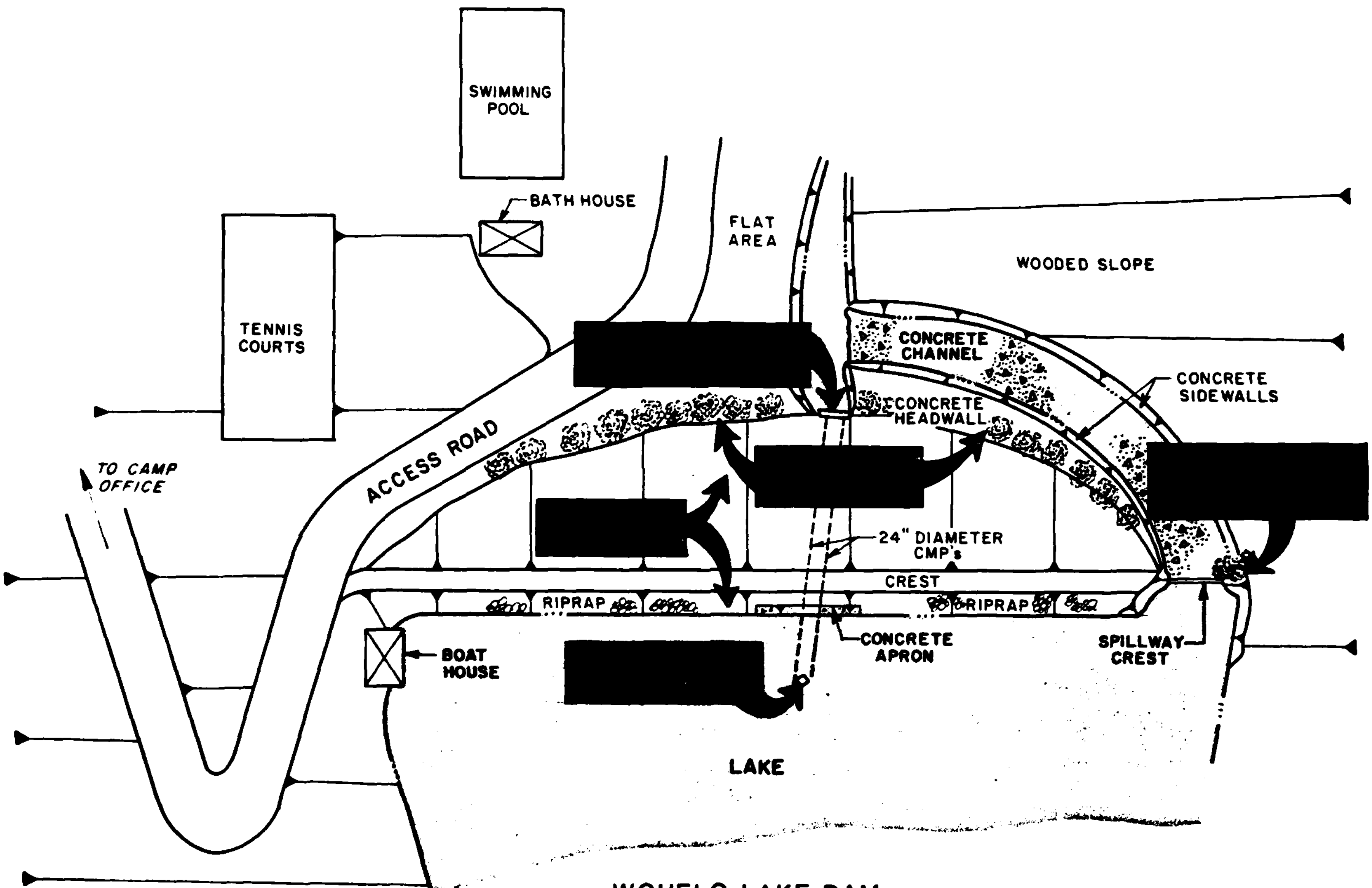
ITEM	OBSERVATIONS/REMARKS/RECOMMENDATIONS NDI# PA - 00326
TYPE AND CONDITION	N/A
APPROACH CHANNEL	N/A
OUTLET STRUCTURE	N/A
DISCHARGE CHANNEL	N/A

INSTRUMENTATION

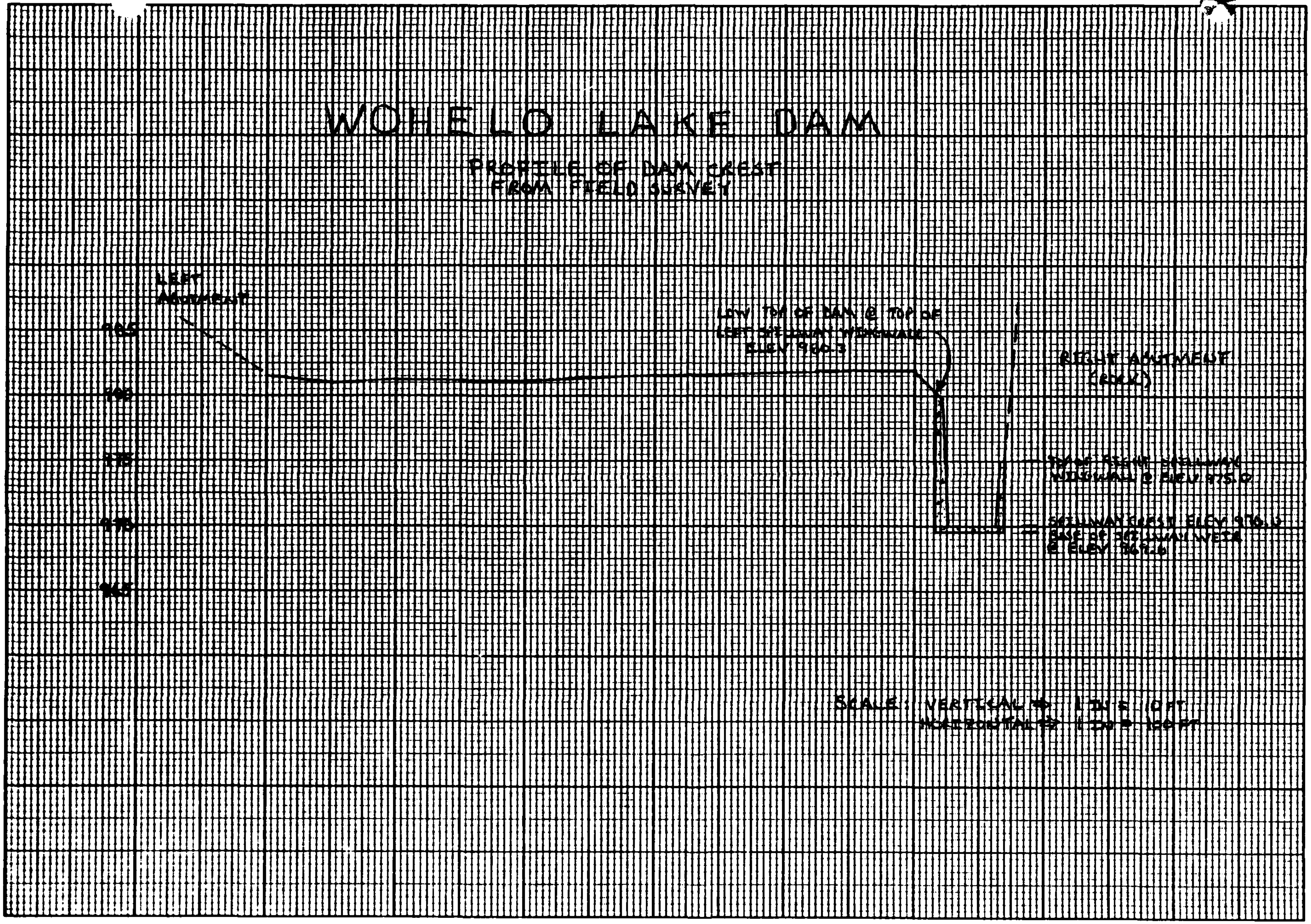
ITEM	OBSERVATIONS/REMARKS/RECOMMENDATIONS NDI# PA- 00326
MONUMENTATION SURVEYS	None.
OBSERVATION WELLS	None.
WEIRS	None.
PIEZOMETERS	None.
OTHERS	

RESERVOIR AREA AND DOWNSTREAM CHANNEL

ITEM	OBSERVATIONS/REMARKS/RECOMMENDATIONS NDI# PA - 00326
SLOPES: RESERVOIR	Steep and heavily forested.
SEDIMENTATION	None evident. Heavy algae growth apparent.
DOWNSTREAM CHANNEL (OBSTRUCTIONS, DEBRIS, ETC.)	Natural channel with no apparent obstructions until it passes beneath Pennsylvania Route 16 about one mile downstream of the dam.
SLOPES: CHANNEL VALLEY	Steep channel with steep and heavily forested confining slopes from the dam to the toe of the mountain located one mile downstream. The channel then flows into a broad flat floodplain and eventually joins the east branch of Antietam Creek about four miles downstream of the dam.
APPROXIMATE NUMBER OF HOMES AND POPULATION	At least a dozen homes and small businesses are located near the stream in the floodplain between one and two miles downstream of the dam.



WOHELO LAKE DAM
GENERAL PLAN - FIELD INSPECTION NOTES


WOHELO LAKE DAM
PROFILE OF DAM CREST
FROM FIELD SURVEY
LEFT ABUTMENT
985
980
975
970
965
LOW TOP OF DAM @ TOP OF LEFT SPILLWAY WINGWALL ELEV 980.3
RIGHT ABUTMENT (ROCK)
TOP OF RIGHT SPILLWAY WINGWALL @ ELEV 975.0
SPILLWAY CREST ELEV 970.0
BASE OF SPILLWAY WEIR @ ELEV 969.6
SCALE: VERTICAL → 1 IN = 10 FT
HORIZONTAL → 1 IN = 100 FT

APPENDIX B

ENGINEERING DATA CHECKLIST

CHECK LIST
ENGINEERING DATA
PHASE I

NAME OF DAM Wohelo Lake Dam

ITEM	REMARKS NDI# PA - 00326
PERSONS INTERVIEWED AND TITLE	Morgan Levy - owner (partner). Ownership is registered to Wohelo Realty Co. 12811 Old Route 16 Waynesboro, PA 17268
REGIONAL VICINITY MAP	See Figure 1, Appendix E.
CONSTRUCTION HISTORY	Constructed in 1953 by E. D. Plummer and Sons of Chambersburg, Pennsylvania. Designed by A. M. Larsen of McConnellsburg, Pennsylvania.
AVAILABLE DRAWINGS	Five (5) drawings available from PennDER files. See Figures 2, 3, 4, 5 and 6, Appendix E. None available from owner.
TYPICAL DAM SECTIONS	See Figure 4, Appendix E.
OUTLETS: PLAN DETAILS DISCHARGE RATINGS	See Figures 2, 4 and 5, Appendix E. Discharge rating curves are not available.

CHECK LIST
ENGINEERING DATA
PHASE I
(CONTINUED)

ITEM	REMARKS NDI# PA- 00326
SPILLWAY: PLAN SECTION DETAILS	See Figures 2, 4 and 5, Appendix E.
OPERATING EQUIP-MENT PLANS AND DETAILS	No details of the operating equipment are available.
DESIGN REPORTS	None.
GEOLOGY REPORTS	None.
DESIGN COMPUTATIONS: HYDROLOGY AND HYDRAULICS STABILITY ANALYSES SEEPAGE ANALYSES	None.
MATERIAL INVESTIGATIONS: BORING RECORDS LABORATORY TESTING FIELD TESTING	None.

CHECK LIST
ENGINEERING DATA
PHASE I
(CONTINUED)

ITEM	REMARKS NDI# PA- 00326
BORROW SOURCES	See Figure 3, Appendix E.
POST CONSTRUCTION DAM SURVEYS	None.
POST CONSTRUCTION ENGINEERING STUDIES AND REPORTS	None.
HIGH POOL RECORDS	Highest pool level recalled by the owner occurred in June 1972 when water rose to a level just above the elevation of the boathouse floor (el. 971.9 feet) located along the left shore. This corresponds to about 2 feet above the spillway crest elevation 970.0 feet.
MONITORING SYSTEMS	None.
MODIFICATIONS	Concrete apron along upstream face placed shortly after construction to correct a seepage problem. Bridge to outlet control was burned by vandals 2 or 3 years ago and never replaced. Concrete placed in spillway in June 1980.

CHECK LIST
ENGINEERING DATA
PHASE I
(CONTINUED)

ITEM	REMARKS NDI# PA- 00326
PRIOR ACCIDENTS OR FAILURES	None.
MAINTENANCE: RECORDS MANUAL	None.
OPERATION: RECORDS MANUAL	None.
OPERATIONAL PROCEDURES	Self-regulating.
WARNING SYSTEM AND/OR COMMUNICATION FACILITIES	Radio communication system between Camps Comet and Wohelo is established.
MISCELLANEOUS	

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CHECK LIST
HYDROLOGIC AND HYDRAULIC
ENGINEERING DATA

NDI ID # PA-00326
PENNDER ID # 28-95

SIZE OF DRAINAGE AREA: 4.0 square miles.

ELEVATION TOP NORMAL POOL: 970.0 STORAGE CAPACITY: 22 acre-feet.

ELEVATION TOP FLOOD CONTROL POOL: - STORAGE CAPACITY: -

ELEVATION MAXIMUM DESIGN POOL: - STORAGE CAPACITY: -

ELEVATION TOP DAM: 980.3 STORAGE CAPACITY: 85 acre-feet.

SPILLWAY DATA

CREST ELEVATION: 970.0 feet.

TYPE: Uncontrolled, trapezoidal shaped, concrete lined chute.

CREST LENGTH: 37.5 feet.

CHANNEL LENGTH: 250 feet.

SPILLOVER LOCATION: Right abutment.

NUMBER AND TYPE OF GATES: None.

OUTLET WORKS

TYPE: Two 24-inch diameter CMPs.

LOCATION: Right of embankment center.

ENTRANCE INVERTS: Not known.

EXIT INVERTS: 952.3 feet.

EMERGENCY DRAWDOWN FACILITIES: 24-inch diameter gate valves at inlets.

HYDROMETEOROLOGICAL GAGES

TYPE: None.

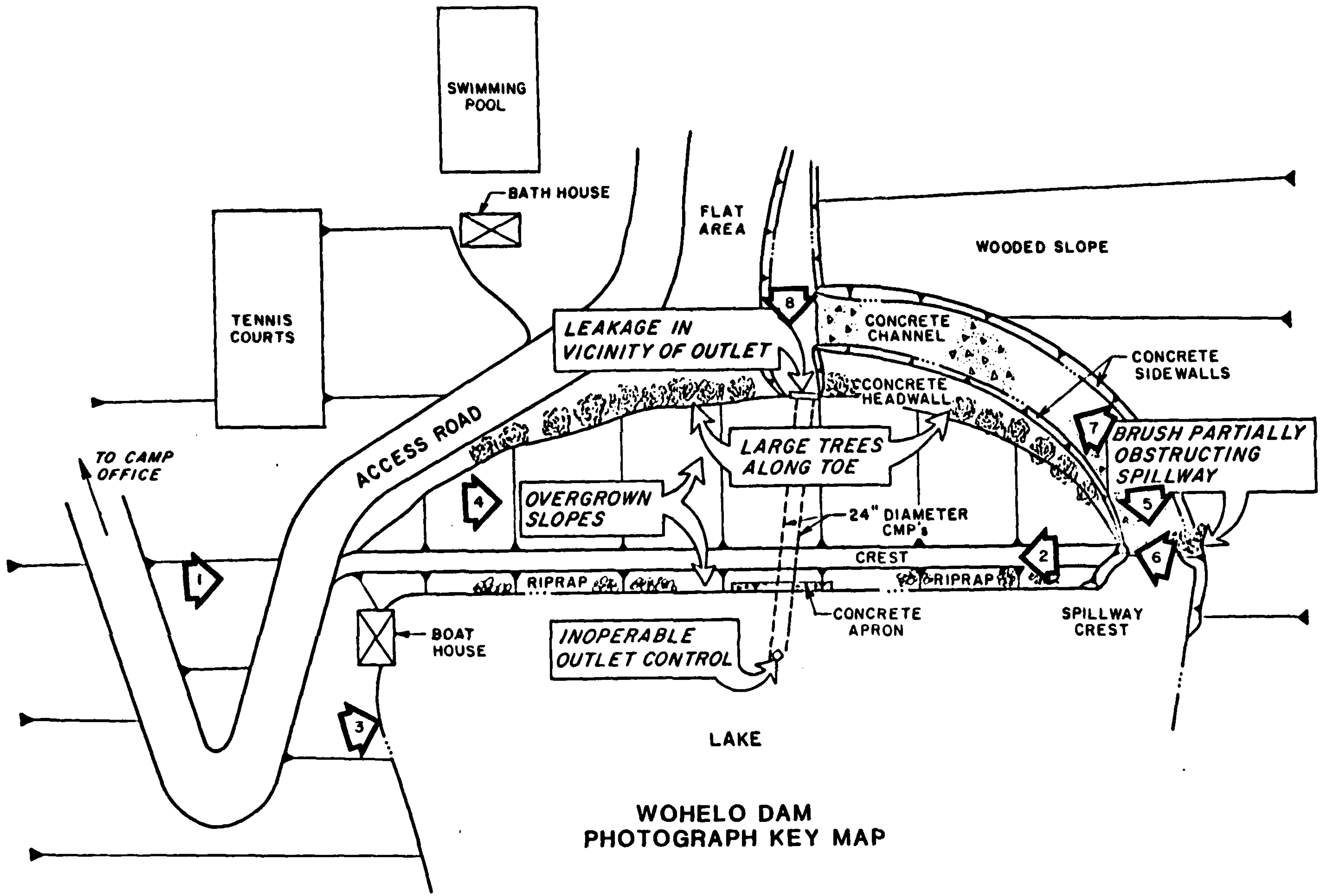
LOCATION: -

RECORDS: -

MAXIMUM NON-DAMAGING DISCHARGE: ≃ 330 cfs (June 1972).

APPENDIX C

PHOTOGRAPHS



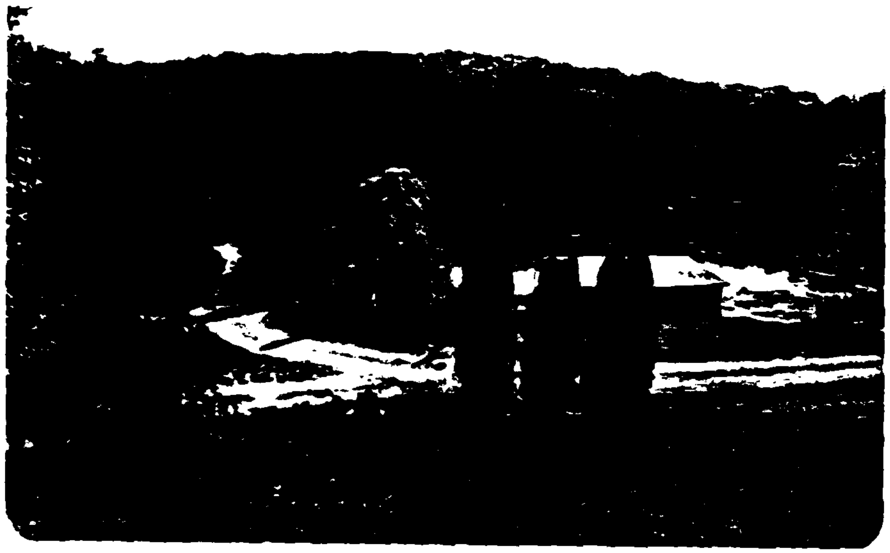
WOHELO DAM
PHOTOGRAPH KEY MAP

PHOTOGRAPH 1 Overview of Wohelo Lake Dam as seen from the left abutment hillside.

PHOTOGRAPH 2 View across the embankment crest looking toward the left abutment.

PHOTOGRAPH 3 View of the upstream embankment face looking toward the right abutment.

PHOTOGRAPH 4 View of the overgrown downstream embankment face looking toward the right abutment. Note the large trees along the downstream toe.



1

2

3

4

PHOTOGRAPH 5 View, looking upstream, of the spillway channel control section. Note the brush projecting into the channel along the left side of the view.

PHOTOGRAPH 6 View of the left spillway channel sidewall at the crest.

PHOTOGRAPH 7 View of the spillway channel looking downstream.

PHOTOGRAPH 8 View of the discharge ends of the outlet conduits.

5

6

7

8

APPENDIX D

HYDROLOGY AND HYDRAULIC ANALYSES

PREFACE

The modified HEC-1 program is capable of performing two basic types of hydrologic analyses: 1) the evaluation of the overtopping potential of the dam; and 2) the estimation of the downstream hydrologic-hydraulic consequences resulting from assumed structural failures of the dam. Briefly, the computational procedures typically used in the dam overtopping analysis are as follows:

a. Development of an inflow hydrograph(s) to the reservoir.

b. Routing of the inflow hydrograph(s) through the reservoir to determine if the event(s) analyzed would overtop the dam.

c. Routing of the outflow hydrograph(s) from the reservoir to desired downstream locations. The results provide the peak discharge(s), time(s) of the peak discharge(s), and the maximum stage(s) of each routed hydrograph at the downstream end of each reach.

The evaluation of the hydrologic-hydraulic consequences resulting from an assumed structural failure (breach) of the dam is typically performed as shown below.

a. Development of an inflow hydrograph(s) to the reservoir.

b. Routing of the inflow hydrograph(s) through the reservoir.

c. Development of a failure hydrograph(s) based on specified breach criteria and normal reservoir outflow.

d. Routing of the failure hydrograph(s) to desired downstream locations. The results provide estimates of the peak discharge(s), time(s) to peak and maximum water surface elevations of failure hydrographs for each location.

HYDROLOGY AND HYDRAULIC ANALYSIS
DATA BASE

NAME OF DAM: WOHELO LAKE DAM

PROBABLE MAXIMUM PRECIPITATION (PMP) = 23.6 INCHES/24 HOURS (1)

STATION	1	2	3
STATION DESCRIPTION	WOHELO LAKE DAM		
DRAINAGE AREA (SQUARE MILES)	4.0		
CUMULATIVE DRAINAGE AREA (SQUARE MILES)	-		
ADJUSTMENT OF PMF FOR DRAINAGE AREA LOCATION (%) (1)			
6 HOURS	113		
12 HOURS	123.5		
24 HOURS	132		
48 HOURS	143		
72 HOURS	-		
SNYDER HYDROGRAPH PARAMETERS	Zone 6		
ZONE (2)	32		
C_p (3)	0.75		
C_t (3)	1.90		
L (MILES) (4)	3.7		
L_{ca} (MILES) (4)	1.2		
$t_p = C_t (L \cdot L_{ca})^{0.3}$ (HOURS)	2.97		
SPILLWAY DATA			
CREST LENGTH (FEET)	37.5		
FREEBOARD (FEET)	10.3		

(1) HYDROMETEOROLOGICAL REPORT - 33, U.S. ARMY CORPS OF ENGINEERS, 1956.

(2) HYDROLOGIC ZONE DEFINED BY CORPS OF ENGINEERS, BALTIMORE DISTRICT, FOR DETERMINATION OF SNYDER COEFFICIENTS (C_p AND C_t).

(3) SNYDER COEFFICIENTS

(4) L = LENGTH OF LONGEST WATERCOURSE FROM DAM TO BASIN DIVIDE.
L_{ca} = LENGTH OF LONGEST WATERCOURSE FROM DAM TO POINT OPPOSITE BASIN CENTROID.

SUBJECT DAM SAFETY INSPECTION
WOHELO LAKE DAM

BY DJS DATE 7-8-80 PROJ. NO. 79-203-326

CHKD. BY WJV DATE 7-29-80 SHEET NO. 1 OF 17

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DAM STATISTICS

HEIGHT OF DAM ≃ 28 FT (FIELD MEASURED; LOW TOP OF DAM TO OUTLET INVERT.)

NORMAL POOL STORAGE CAPACITY ≃ 7 X 10^6 GALLONS
≃ 21.5 AC-FT (SEE NOTE 1)

MAXIMUM POOL STORAGE CAPACITY ≃ 85 AC-FT (HEC-1)
(@ LOW TOP OF DAM)

DRAINAGE AREA ≃ 4.0 SQUARE MILES (PLANIMETERED ON USGS TOPO QUADS: SMITHSBURG, BLUE RIDGE SUMMIT, AND IRON SPRINGS, PA)

ELEVATIONS:

TOP OF DAM (DESIGN)	≃	981.5	(FIG. 2; SEE NOTE 2)
TOP OF DAM (FIELD)	≃	980.3	
NORMAL POOL	≃	970.0	(FIG. 2, SEE NOTE 2)
SPILLWAY CREST	≃	970.0	(FIG. 2; SEE NOTE 2)
UPSTREAM INLET INVERT (DESIGN)	≃	NOT KNOWN	
DOWNSTREAM OUTLET INVERT (DESIGN)	≃	952.4	(FIG 2; SEE NOTE 2)
DOWNSTREAM OUTLET INVERT (FIELD)	≃	952.3	
STREAMBED @ DAM CENTERLINE	≃	952.8	(ESTIMATED FROM FIG. 3, SEE NOTE 2)

NOTE 1:

OBTAINED FROM "DAMS, RESERVOIRS, AND NATURAL LAKES," WATER RESOURCES BULLETIN NO. 5, COMMONWEALTH OF PENNSYLVANIA, DEPT. OF FORESTS AND WATER, HARRISBURG, PA, 1970, AND FIG. 3.

SUBJECT	DAM SAFETY INSPECTION WOHELO LAKE DAM		
BY DJS	DATE 7-8-80	PROJ. NO. 79-303-336	
CHKD. BY WJV	DATE 7-29-80	SHEET NO. 2	OF 17

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NOTE 2:

THE DESIGN DRAWINGS ARE BASED ON A NORMAL POOL OR SPILLWAY ELEVATION OF 1011.2. HOWEVER, THE USGS TOPO QUAD FOR SMITHSBURG, PA, INDICATES THAT THE NORMAL POOL ELEVATION IS SOMEWHERE BETWEEN 960.0 AND 980.0. THEREFORE, IT WILL BE ASSUMED THAT THE SPILLWAY CREST IS AT ELEVATION 970.0, AND 41.2 FEET (OR 1011.2 - 970.0) WILL BE SUBTRACTED FROM ALL THE REPORTED ELEVATIONS ON THE DESIGN DRAWINGS. IT IS NOTED THAT ALL ELEVATIONS USED IN THIS ANALYSIS ARE CONSIDERED ESTIMATES, AND ARE NOT NECESSARILY ACCURATE.

DAM CLASSIFICATION

DAM SIZE:	SMALL	(REF 1, TABLE 1)
HAZARD CLASSIFICATION:	HIGH	(FIELD OBSERVATION)
REQUIRED SDF:	1/2 PMF TO PMF	(REF 1, TABLE 3)

HYDROGRAPH PARAMETERS

LENGTH OF LONGEST WATERCOURSE: $L = 3.7$ MILES

LENGTH OF LONGEST WATERCOURSE FROM DAM TO A POINT OPPOSITE BASIN CENTROID: $L_{CA} = 1.2$ MILES

(MEASURED ON USGS TOPO QUAD: SMITHSBURG, BLUE RIDGE SUMMIT, AND IRON SPRINGS, PA)

$C_t \simeq 1.90$
$C_p \simeq 0.75$

(SUPPLIED BY C.O.E.; ZONE 32, POTOMAC RIVER BASIN, WEST OF MONOCACY RIVER.)

SNYDER'S STANDARD LAG:

$$t_p = C_t (L \cdot L_{ca})^{0.3}$$
$$\simeq 1.90 (3.7 \times 1.2)^{0.3}$$
$$\simeq \underline{2.97} \text{ HOURS}$$

(NOTE: HYDROGRAPH VARIABLES USED HERE ARE DEFINED IN REF. 2, IN SECTION ENTITLED "SNYDER SYNTHETIC UNIT HYDROGRAPH.")

RESERVOIR CAPACITY

RESERVOIR SURFACE AREAS:

SURFACE AREA (S.A.) @ NORMAL POOL (ELEV. 970.0) ≃ 3.8 ACRES (FIG. 2)

S.A. @ ELEV. 980 ≃ 8.6 ACRES
S.A. @ ELEV. 1000 ≃ 20.4 ACRES

(PLANIMETERED ON USGS TOPO QUAD, SMITHSBURG, PA)

S.A. @ LOW TOP OF DAM (ELEV. 980.3) ≃ 8.8 ACRES
(BY LINEAR INTERPOLATION)

"ZERO-STORAGE" ELEVATION:

BY USE OF THE CONIC METHOD,
VOLUME @ NORMAL POOL = $\frac{1}{3}HA$,

WHERE H = MAXIMUM DEPTH OF RESERVOIR, IN FT,
A = SURFACE AREA @ NORMAL POOL ≃ 3.8 ACRES.

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$$VOL = \tfrac{1}{3} HA$$

$$21.5 \text{ AC-FT} = \tfrac{1}{3} H (3.8)$$

$$H = \frac{3(21.5)}{(3.8)} \simeq \underline{17.0} \text{ FT}$$

$\therefore$ ZERO-STORAGE ASSUMED AT $970.0 - 17.0 \simeq \underline{953.0}$

NOTE: ALTHOUGH THE MINIMUM RESERVOIR ELEVATION DOES NOT NECESSARILY OCCUR AT ELEV. 953.0, THIS VALUE DOES SEEM REASONABLE ACCORDING TO FIG. 3, AND IT MUST BE USED IN THE HEC-1 INPUT IN ORDER TO MAINTAIN A STORAGE OF 21.5 AC-FT AT NORMAL POOL.

ELEVATION-STORAGE RELATIONSHIP:

AN ELEVATION-STORAGE RELATIONSHIP IS COMPUTED INTERNALLY IN THE HEC-1 PROGRAM, BY USE OF THE CONIC METHOD, BASED ON THE ELEVATION-SURFACE AREA DATA GIVEN ABOVE. (SEE SUMMARY INPUT/OUTPUT SHEETS.)

SUBJECT DAM SAFETY INSPECTION
WOHELO LAKE DAM

BY DJJ DATE 7-8-80 PROJ. NO. 79-203-326

CHKD. BY WJV DATE 7-29-90 SHEET NO. 5 OF 17

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PMP CALCULATIONS

- APPROXIMATE RAINFALL INDEX = 23.6 INCHES (CORRESPONDING TO A DURATION OF 24 HOURS AND A DRAINAGE AREA OF 200 SQUARE MILES)

(REF 3, FIG. 1)

- DEPTH - AREA - DURATION ZONE 6 (REF 3, FIG. 1)

- ASSUME DATA CORRESPONDING TO A 10-SQUARE MILE AREA MAY BE APPLIED TO THIS 4.0 SQUARE MILE BASIN:

DURATION (HRS)	PERCENT OF INDEX RAINFALL
6	113
12	123.5
24	132
48	143

(REF 3, FIG. 3)

HOP BROOK FACTOR (ADJUSTMENT FOR BASIN SHAPE AND FOR THE LESSER LIKELIHOOD OF A SEVERE STORM CENTERING OVER A SMALL BASIN) FOR A DRAINAGE AREA OF 4.0 SQUARE MILES IS 0.80.

(REF 4, p. 48)

SUBJECT DAM SAFETY INSPECTION
WOHELO LAKE DAM

BY RJS DATE 7-9-80 PROJ. NO. 79-203-326
CHKD. BY WJV DATE 7-29-80 SHEET NO. 6 OF 17

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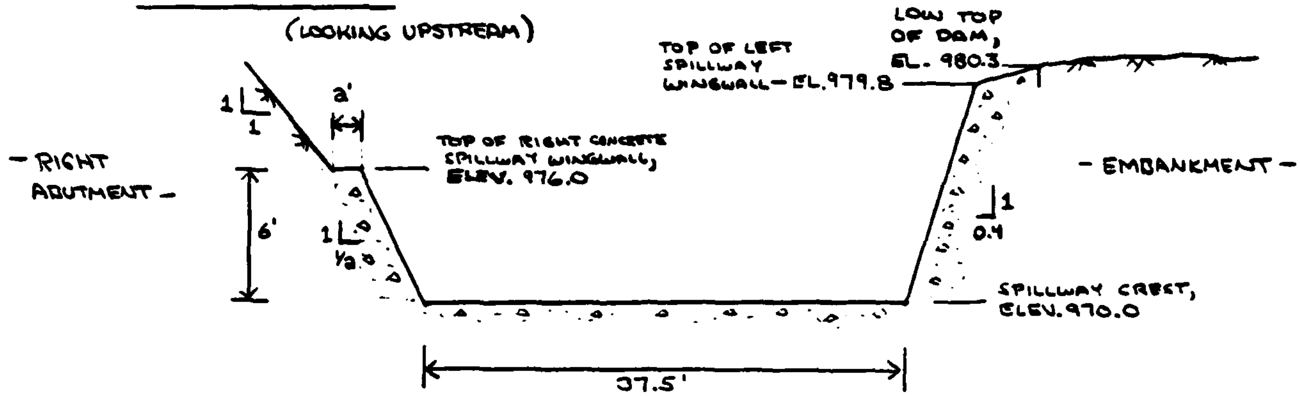
SPILLWAY CAPACITY

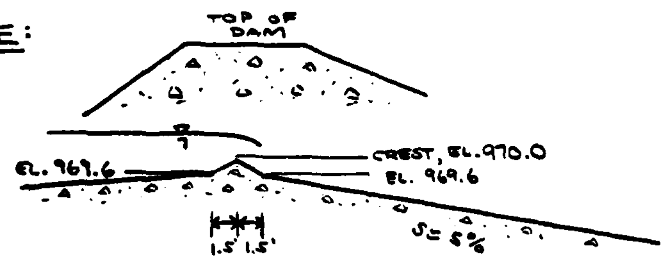
CROSS-SECTION :

(LOOKING UPSTREAM)



- NOT TO SCALE -

PROFILE:



- NOT TO SCALE -

(SKETCHES BASED ON FIELD MEASUREMENTS AND OBSERVATIONS.)

THE SPILLWAY CONSISTS OF A CONCRETE LINED CHANNEL CUT IN ROCK AT THE RIGHT ABUTMENT. THE ASSUMED CONTROL SECTION IS LOCATED AT THE SMALL CONCRETE BERM AT THE RESERVOIR OUTLET, SHOWN ABOVE.

SUBJECT DAM SAFETY INSPECTION

WOHELO LAKE DAM

BY DJS DATE 7-9-80 PROJ. NO. 79-203-326

CHKD. BY WJV DATE 7-29-80 SHEET NO. 7 OF 17

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ASSUME THAT DISCHARGE AT THE OUTLET CAN BE ESTIMATED BY THE WEIR EQUATION:

$$Q = CLH^{3/2} \qquad \text{(REF 5, p. 5-23)}$$

WHERE Q = DISCHARGE, IN CFS,
C = DISCHARGE COEFFICIENT,
L = LENGTH OF "WEIR" = 37.5 FT,
H = HEAD, IN FT.

ASSUMING THAT CRITICAL FLOW OCCURS AT THE CONTROL SECTION, THE COEFFICIENT OF DISCHARGE WILL BE 3.087 (REF 5, p. 5-24). ALSO, SINCE THE CONTROL SECTION IS NOT RECTANGULAR, AN AREA-CORRECTION FACTOR WILL BE APPLIED, BASED ON THE ASSUMPTION THAT THE DISCHARGE OVER THE SIDEWALLS OCCURS AT THE SAME VELOCITY AS THE DISCHARGE OVER THE "WEIR".

$$Q_T = Q_W \left(\frac{A_T}{A_W}\right)$$

WHERE Q_T, A_T REFER TO TOTAL SPILLWAY DISCHARGE AND FLOW AREA, RESPECTIVELY, AND Q_W, A_W REFER TO DISCHARGE AND FLOW AREA DIRECTLY OVER BERM OR "WEIR".

ESTIMATE APPROACH CHANNEL LOSSES:

LENGTH ≈ 27 FT (FIG. 2)
WIDTH = 37.5 FT

– CALCULATE LOSSES @ ELEV. 976.0 (TOP OF RIGHT WINGWALL):

$$\text{AVG. DEPTH IN CHANNEL} \simeq 976.0 - \left(\frac{969.6 + 968.7}{2}\right)$$
$$\simeq 6.9 \text{ FT}$$

SUBJECT DAM SAFETY INSPECTION

WOHELO LAKE DAM

BY DJS DATE 7-9-80 PROJ. NO. 79-203-326

CHKD. BY WJV DATE 7-29-80 SHEET NO. 8 OF 17

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- ASSUME SIDE-SLOPES ARE CONSISTENT WITH THOSE AT THE OUTLET, OR 0.5H:1V AND 0.4H:1V (SEE SHEET 6).

INITIAL ESTIMATE OF DISCHARGE:

$$@\ ELEV.\ 976.0, \quad Q = CLH^{3/2} \times \frac{A_T}{A_W}$$

$$\simeq \left[(3.087)(37.5)(6^{3/2})\right]\left[\frac{\left(\frac{37.5+43.9}{2}\right)(6)}{(37.5)(6)}\right]$$

$$\simeq \underline{1824}\ CFS$$

AVG. VELOCITY IN APPROACH CHANNEL:

$$V_a = \frac{Q}{A} = \frac{1824}{(6.9)\left[\frac{(37.5+43.7)}{2}\right]} \simeq \frac{1824}{280}$$

$$V_a \simeq \underline{6.5}\ FPS$$

AVG. VELOCITY HEAD:

$$h_a = \frac{V_a^2}{2g} = \frac{6.5^2}{64.4} \simeq \underline{0.66}\ FT$$

ENTRANCE LOSS FOR APPROACH CHANNEL $= 0.1\, h_a$ (REF 4, p. 379)

$$\simeq \underline{0.07}\ FT$$

APPROACH CHANNEL FRICTION LOSS:

$$h_F = \left[\frac{V_a\, n}{1.49 R^{2/3}}\right]^2 \times L_c \qquad \text{(REF 4, p. 379)}$$

WHERE L_c = LENGTH OF APPROACH CHANNEL $\simeq$ 27 FT

n = MANNING'S ROUGHNESS COEFFICIENT $\simeq$ 0.025 (FIELD ESTIMATE)

R = HYDRAULIC RADIUS = FLOW AREA / WETTED PERIMETER

$$R = \frac{280}{37.5 + 7.4 + 7.7} \simeq \underline{5.3}\ FT$$

$$h_F = \left[\frac{(6.5)(0.025)}{(1.49)(5.3)^{2/3}}\right]^2 \times 27 \simeq \underline{0.03}\ FT$$

$\therefore$ TOTAL ENTRANCE LOSS @ ELEV 976.0 $= h_F$ + ENTRANCE LOSS

$$\simeq 0.03 + 0.07 \simeq \underline{0.10}\ FT$$

SUBJECT DAM SAFETY INSPECTION

WOHELO LAKE DAM

BY DJS DATE 7-10-80 PROJ. NO. 79-203-326

CHKD. BY WJV DATE 7-29-80 SHEET NO. 9 OF 17

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FOR HEADS OTHER THAN 6.0, APPROACH CHANNEL LOSSES WILL BE ASSUMED TO BE PROPORTIONAL TO THAT AT $H=6.0$:

$$h_L = 0.10\left(\frac{H}{6.0}\right)$$

WHERE h_L = TOTAL APPROACH LOSS, IN FT,
H = RESERVOIR ELEVATION − 970.0.

SPILLWAY RATING TABLE:

RESERVOIR ELEVATION (FT)	H (FT)	h_L ① (FT)	He ② (FT)	Qw ③ (CFS)	Aw ④ (FT²)	AT ⑤ (FT²)	QT ⑥ (CFS)
970.0	—	—	—	—	—	—	0
971.0	1.0	0.02	0.98	112	37	37	110
972.0	2.0	0.03	1.97	320	74	76	330
973.0	3.0	0.05	2.95	587	111	115	610
974.0	4.0	0.07	3.93	902	147	154	940
975.0	5.0	0.08	4.92	1263	185	195	1330
(TOP OF RIGHT WINGWALL) 976.0	6.0	0.10	5.90	1659	221	237	1780
977.0	7.0	0.12	6.88	2089	258	281	2330
978.0	8.0	0.13	7.87	2556	295	328	2840
979.0	9.0	0.15	8.85	3048	332	375	3440
(TOP OF LEFT WINGWALL) 979.8	9.8	0.16	9.64	3465	362	414	3960
980.0	10.0	0.17	9.83	3568	369	423	4090
(LOW TOP OF DAM) 980.3	10.3	0.17	10.13	3732	380	439	4310
981.0	11.0	0.18	10.82	4120	406	474	4810
981.5	11.5	0.19	11.31	4403	424	499	5180
982.0	12.0	0.20	11.80	4692	443	524	5550
983.0	13.0	0.22	12.78	5289	479	575	6350
984.0	14.0	0.23	13.77	5915	516	629	7210
985.0	15.0	0.25	14.75	6558	553	683	8100
986.0	16.0	0.27	15.73	7222	590	737	9020

① $h_L = 0.10\left(\frac{H}{6.0}\right)$

② He = EFFECTIVE HEAD = $H - h_L$

SUBJECT: DAM SAFETY INSPECTION
WOHELO LAKE DAM

BY: DJS DATE: 7-10-80 PROJ. NO. 79-203-326

CHKD. BY: WJV DATE: 7-29-80 SHEET NO. 10 OF 17

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(3) $Q_w = (3.087)(37.5)H_e^{3/2}$

(4) $A_w = 37.5 \times H_e$

(5) FOR $H_e \le 6.0$, $A_T = \left[\dfrac{37.5 + (37.5 + 0.44H_e + 0.54)}{2}\right] H_e$

FOR $6.0 \le H_e \le 9.8$, $A_T = 241.2 + \left[\dfrac{44.9 + (44.9 + 1.4\{H_e - 6\})}{2}\right](H_e - 6)$

FOR $H_e \ge 9.8$, $A_T = 421.9 + \left[\dfrac{50.2 + (50.2 + 1.0\{H_e - 9.8\})}{2}\right](H_e - 9.8)$

(6) $Q_T = Q_w \left(\dfrac{A_T}{A_w}\right)$

EMBANKMENT RATING CURVE

ASSUME THAT THE EMBANKMENT BEHAVES ESSENTIALLY AS A BROAD-CRESTED WEIR WHEN OVERTOPPING OCCURS. THUS, THE DISCHARGE CAN BE ESTIMATED BY THE RELATIONSHIP

$$Q = CLH^{3/2} \qquad \text{(REF 5, p. 5-23)}$$

WHERE
- Q = DISCHARGE OVER EMBANKMENT, IN CFS,
- L = LENGTH OF EMBANKMENT OVERTOPPED, IN FT,
- H = HEAD, IN FT; IN THIS CASE IT IS THE AVERAGE "FLOW AREA WEIGHTED" HEAD ABOVE THE LOW TOP OF DAM,
- C = COEFFICIENT OF DISCHARGE, DEPENDENT UPON THE HEAD AND THE WEIR BREADTH.

LENGTH OF EMBANKMENT INUNDATED VS RESERVOIR ELEVATION:

	ELEVATION (FT)	LENGTH (FT)	ELEVATION (FT)	LENGTH (FT)
(TOP OF LEFT SPWY WINGWALL)	979.8	0	982.0	525
(LOW TOP OF DAM)	980.3	5	983.0	535
	981.0	15	984.0	545
	981.2	100	985.0	555
	981.3	210	986.0	565
	981.6	320		

(FROM FIELD SURVEY AND USGS TOPO - SMITHSBURG; LEFT ABUTMENT SS: 10H TO 1V

JBJECT	DAM SAFETY INSPECTION
	WOHELO LAKE DAM
BY DJS	DATE 7-10-80	PROJ. NO. 79-203-326
CHKD. BY WJV	DATE 7-29-80	SHEET NO. 11 OF 17

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ASSUME THAT INCREMENTAL DISCHARGES OVER THE EMBANKMENT FOR SUCCESSIVE RESERVOIR ELEVATIONS ARE APPROXIMATELY TRAPEZOIDAL IN CROSS-SECTIONAL FLOW AREA. THEN ANY INCREMENTAL AREA OF FLOW CAN BE ESTIMATED AS $H_i[(L_1+L_2)/2]$, WHERE L_1 = LENGTH OF OVERTOPPED EMBANKMENT AT HIGHER ELEVATION, L_2 = LENGTH OF OVERTOPPED EMBANKMENT AT LOWER ELEVATION, H_i = DIFFERENCE IN ELEVATIONS. THUS, THE TOTAL AVERAGE "FLOW AREA WEIGHTED" HEAD CAN BE ESTIMATED AS $H_w \simeq$ (TOTAL FLOW AREA / L_1).

EMBANKMENT RATING TABLE:

	RESERVOIR ELEVATION (FT)	L_1 (FT)	L_2 (FT)	INCREMENTAL HEAD, H_i (FT)	① INCREMENTAL FLOW AREA, A_i (FT^2)	TOTAL FLOW AREA, A_T (FT^2)	② WEIGHTED HEAD, H_w (FT)	③ H_w/ℓ	④ C	⑤ Q (CFS)
(TOP OF WINGWALL)	979.8	0	—	0	—	—	—	—	—	0
(LOW TOP OF DAM)	980.3	5	0	0.5	1	1	0.2	0.03	2.97	0
	981.0	15	5	0.7	7	8	0.5	0.08	3.02	20
	981.2	100	15	0.2	12	20	0.2	0.03	2.97	30
	981.3	210	100	0.1	16	36	0.2	0.03	2.97	60
	981.6	320	210	0.3	80	116	0.4	0.07	3.01	240
	982.0	525	320	0.4	169	285	0.5	0.08	3.02	560
	983.0	535	525	1.0	530	815	1.5	0.25	3.08	3030
	984.0	545	535	1.0	540	1355	2.5	0.42	3.09	6660
	985.0	555	545	1.0	550	1905	3.4	0.57	3.09	10,75[illegible]
	986.0	565	555	1.0	560	2465	4.4	0.73	3.09	16,11[illegible]

① $A_i \simeq H_i[(L_1+L_2)/2]$
② $H_w \simeq A_T/L_1$
③ ℓ = BREADTH OF CREST $\simeq$ 6 FT
④ $C = f(H,\ell)$; FROM REF 12, FIG. 24
⑤ $Q \simeq CL_1H_w^{3/2}$

JBJECT DAM SAFETY INSPECTION

WOHELO LAKE DAM

BY DJS DATE 7-10-80 PROJ. NO. 79-303-326

CHKD. BY WJV DATE 7-29-80 SHEET NO. 12 OF 17

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TOTAL FACILITY RATING TABLE

$Q_{TOTAL} = Q_{SPILLWAY} + Q_{EMBANKMENT}$

	RESERVOIR ELEVATION (FT)	① $Q_{SPILLWAY}$ (CFS)	② $Q_{EMBANKMENT}$ (CFS)	Q_{TOTAL} (CFS)
	970.0	0	-	0
	971.0	110	-	110
	972.0	330	-	330
	973.0	610	-	610
	974.0	940	-	940
	975.0	1330	-	1330
(TOP OF RIGHT SPILLWAY WINGWALL)	976.0	1780	-	1780
	977.0	2280	-	2280
	978.0	2840	-	2840
	979.0	3440	-	3440
(TOP OF LEFT SPILLWAY WINGWALL)	979.8	3960	0	3960
	980.0	4090	0	4090
(LOW TOP OF DAM)	980.3	4310	0	4310
	981.0	4810	20	4830
	981.2	4960 *	30	4990
	981.3	5030 *	60	5090
	981.6	5250 *	240	5490
	982.0	5550	560	6110
	983.0	6350	3030	9380
	984.0	7210	6660	13,870
	985.0	8100	10,750	18,850
	986.0	9020	16,110	25,130

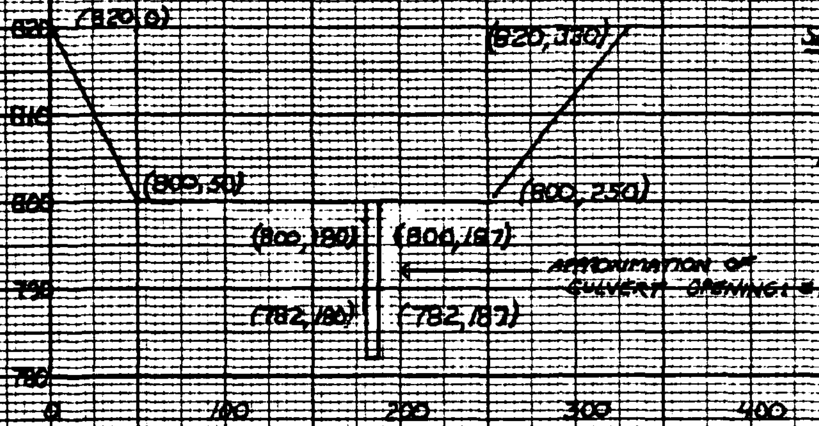
* BY LINEAR INTERPOLATION

① FROM SHEET 9

② FROM SHEET 11

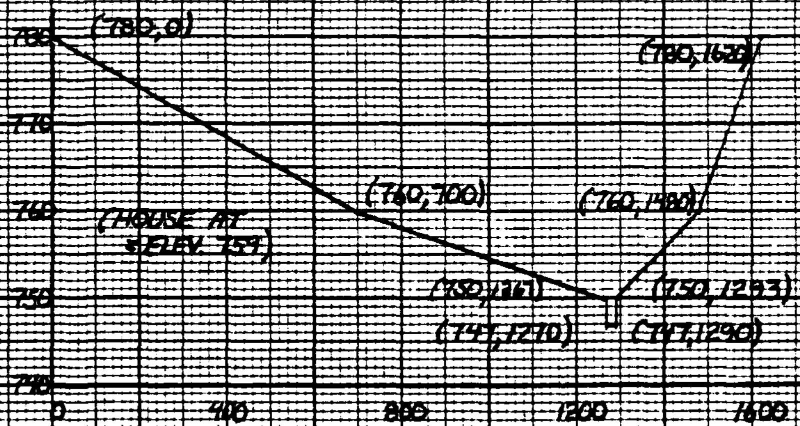
SUBJECT	[illegible] Lake Dam
BY [illegible] DATE 7-22-80	SHEET NO. 13 OF 17
CHKD. BY WJ DATE 7-29-80	PROJECT NO. 79-203-396

DOWNSTREAM ROUTING SECTIONS

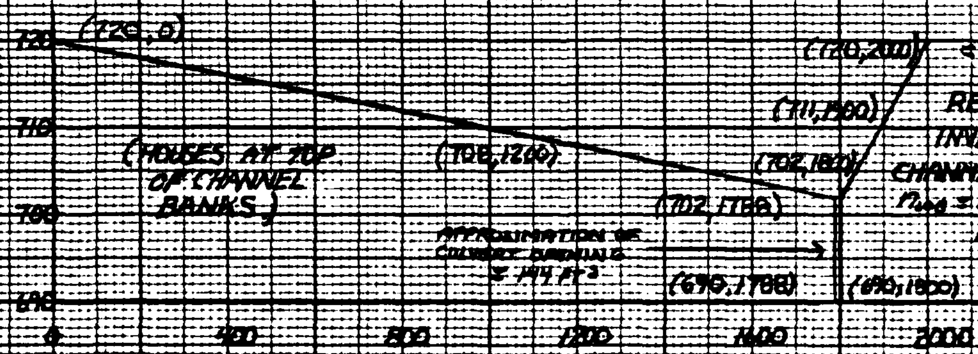


SECTION 2.0
≈ 4820 FT D.S. FROM DAM
INVERT ≈ 782.0
CHANNEL SLOPE ≈ 0.043
$n_{LOB} \approx 0.100$, $n_{ROB} \approx 0.080$
$n_{CH} \approx 0.040$

SECTION 3.0
≈ 6660 FT D.S. FROM DAM
REACH LENGTH ≈ 1840 FT
INVERT ≈ 747.0
CHANNEL SLOPE ≈ 0.020
$n_{LOB} \approx n_{ROB} \approx 0.080$
$n_{CH} \approx 0.035$



SECTION 4.0
≈ 10440 FT D.S. FROM DAM
REACH LENGTH ≈ 3780
INVERT ≈ 690.0
CHANNEL SLOPE ≈ 0.014
$n_{LOB} \approx n_{ROB} \approx 0.090$
$n_{CH} \approx 0.035$



NOTE: SECTIONS BASED ON FIELD NOTES AND OBSERVATIONS AND USGS TOPO QUAD - SMITHSBURG, PA. ELEVATIONS ARE CONSIDERED ESTIMATES AND ARE NOT NECESSARILY ACCURATE.

JBJECT DAM SAFETY INSPECTION

WOHELO LAKE DAM

BY DJS DATE 7-23-80 PROJ. NO. 79-203-326

CHKD. BY WJV DATE 7-29-80 SHEET NO. 14 OF 17

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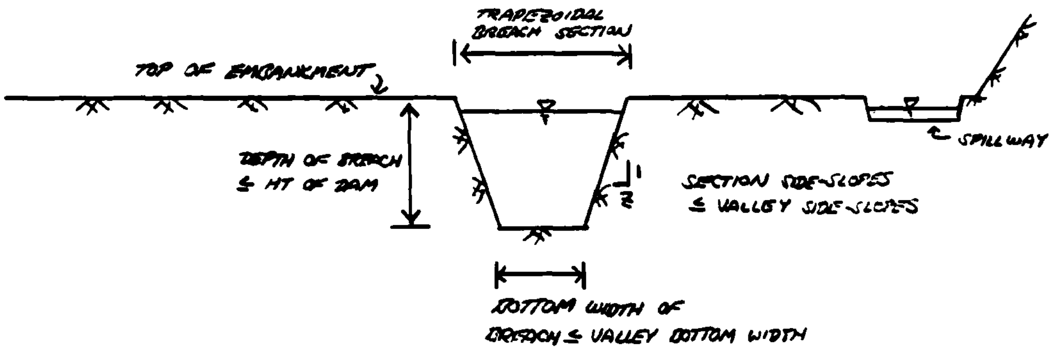
BREACH ASSUMPTIONS

TYPICAL BREACH SECTION:



HEC-1 BREACHING ANALYSIS INPUT:

(BREACHING ASSUMED TO COMMENCE WHEN RESERVOIR LEVEL REACHES LOW TOP OF DAM – EL. 980.3)

PLAN	BREACH BOTTOM WIDTH (FT)	MAX. BREACH DEPTH (FT)	SECTION SIDE-SLOPES	BREACH TIME (HRS)
① MIN. BREACH SECTION, MIN. FAIL TIME	0	27	1H:1V	0.5
② MAX. BREACH SECTION, MIN. FAIL TIME	300	27	4:1	0.5
③ MIN. BREACH SECTION, MAX. FAIL TIME	0	27	1:1	4.0
④ MAX. BREACH SECTION, MAX. FAIL TIME	300	27	4:1	4.0
⑤ AVERAGE POSSIBLE CONDITIONS	100	27	1:1	2.0

SUBJECT	DAM SAFETY INSPECTION				
	WOHELO LAKE DAM				
BY	DJS	DATE	7-23-80	PROJ. NO.	79-203-326
CHKD. BY	WJV	DATE	7-29-80	SHEET NO.	15 OF 17

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THE BREACH ASSUMPTIONS LISTED ON THE PRECEDING SHEET ARE BASED ON THE SUGGESTED RANGES PROVIDED BY THE C.O.E. (BALTIMORE DISTRICT), AND ON THE PHYSICAL CONSTRAINTS OF THE DAM AND SURROUNDING TERRAIN:

- DEPTH OF BREACH OPENING ≈ 27 FT (TOP OF DAM TO MINIMUM RESERVOIR ELEVATION)

- LENGTH OF BREACHABLE EMBANKMENT ≈ 590 FT (FIELD MEASURED)

- VALLEY BOTTOM WIDTH ≈ 300 FT (FIELD OBSERVATION; USGS TOPO, SMITHSBURG, PA)

- VALLEY SIDE-SLOPES ADJACENT TO DAM:

RIGHT: 5H:1V (USGS TOPO QUAD - SMITHSBURG, ...
LEFT: 5H:1V

JBJECT DAM SAFETY INSPECTION

WOHELO LAKE DAM

BY DJS DATE 7-24-80 PROJ. NO. 79-203-326

CHKD. BY WJV DATE 7-29-80 SHEET NO. 16 OF 17

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HEC-1 DAM BREACHING ANALYSIS OUTPUT SUMMARY:

RESERVOIR DATA: (UNDER 0.45 PMF BASE FLOW CONDITIONS)

PLAN * NUMBER	VARIABLE BREACH BOTTOM WIDTH (FT)	ACTUAL MAX. FLOW DURING FAIL TIME (CFS)	CORRESPONDING TIME OF PEAK (HRS)	INTERPOLATED OR HEC-1 ROUTED MAX FLOW DURING FAIL TIME (CFS)	CORRESPONDING TIME OF PEAK (HRS)	ACTUAL PEAK FLOW THROUGH DAM (CFS)	CORRESPONDING TIME OF PEAK (HRS)	TIME OF INITIAL BREACH (HRS)
1	0	6755	42.50	6755	42.50	6755	42.50	42.00
2	300	8388	42.12	8115	42.17	8388	42.12	42.00
3	0	4570	42.67	4570	42.67	4570	42.67	42.00
4	300	5026	42.50	5026	42.50	5026	42.50	42.00
5	100	5311	42.50	5311	42.50	5311	42.50	42.00

* SEE SHEET 14.

SUBJECT DAM SAFETY INSPECTION
WOHELO LAKE DAM

BY RJJ DATE 7-24-80 PROJ. NO. 79-303-326
CHKD. BY WJV DATE 7-29-80 SHEET NO. 17 OF 17

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DOWNSTREAM ROUTING DATA:

(UNDER 0.45 PMF BASE FLOW CONDITIONS)

OUTPUT AT SECTION 4, 10440 FT D.S. FROM DAM:

PLAN NUMBER (1)	VARIABLE BREACH BOTTOM WIDTH (FT)	PEAK FLOW (CFS)	CORRESPONDING W.S.EL. (2) (FT)	W.S.EL. (3) W/O BREACH (FT)	ELEVATION (4) DIFFERENCE (FT)
1	0	5452	705.9	705.3	+0.6
2	300	5709	706.0	705.3	+0.7
3	0	4510	705.3	705.3	—
4	300	4911	705.6	705.3	+0.3
5	100	5155	705.7	705.3	+0.4

(1) SEE SHEET 14

(2) WATER SURFACE ELEVATION CORRESPONDING TO BREACH OUTFLOW (SUMMARY INPUT/OUTPUT SHEETS, SHEET L.)

(3) BASE FLOW ELEVATION CORRESPONDING TO THE PEAK 0.45 PMF AS INTERPOLATED FROM SHEET E, SUMMARY INPUT/OUTPUT SHEETS.

(4) ELEV. DIFF. = (CORRESPONDING W.S.EL.) − (W.S.EL. W/O BREACH).

NOTE: DAMAGE LEVEL OF RESIDENCES AT TOP OF CHANNEL BANKS, APPROXIMATED AS ELEVATION 703.0.

SUBJECT DAM SAFETY INSPECTION
WOHELO LAKE DAM

BY WJV DATE 7-29-80 PROJ. NO. 79-203-326

CHKD. BY DJJ DATE 7-29-80 SHEET NO. A OF L

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SUMMARY INPUT/OUTPUT SHEETS

OVERTOPPING ANALYSIS

```
                DAM SAFETY INSPECTION
                WOHELO LAKE DAM **** OVERTOPPING ANALYSIS ****
                10-MINUTE TIME STEP AND 48-HOUR STORM DURATION

                              JOB SPECIFICATION
     NQ     NHR    NMIN   IDAY    IHR    IMIN   METRC   IPLT   IPRT   NSTAN
    288       0      10      0      0       0       0      0      0       0
                         JOPER    NWT   LROPT   TRACE
                             5      0       0       0

                       MULTI-PLAN ANALYSES TO BE PERFORMED
                         NPLAN= 1 NRTIO= 5 LRTIO= 1
     RTIOS=    .30    .40    .50    .60   1.00

**********     **********     **********     **********     **********

                          SUB-AREA RUNOFF COMPUTATION

     RESERVOIR INFLOW HYDROGRAPH

          ISTAQ   ICOMP   IECON   ITAPE   JPLT   JPRT   INAME  ISTAGE  IAUTO
              1       0       0       0      0      0       1       0      0

                               HYDROGRAPH DATA
     IHYDG   IUHG   TAREA   SNAP   TRSDA   TRSPC   RATIO   ISNOW   ISAME   LOCAL
         1      1    4.00   0.00    4.00    0.00   0.000       0       1       0

                                 PRECIP DATA
              SPFE     PMS      R6     R12     R24     R48     R72     R96
              0.00   23.60  113.00  123.50  132.00  143.00    0.00    0.00
TRSPC COMPUTED BY THE PROGRAM IS  .800

                                                      INITIAL + CONSTANT
                                   LOSS DATA          RAINFALL LOSS (G.E.)
     LROPT   STRKR   DLTKR   RTIOL   ERAIN   STRKS   RTIOK   STRTL   CNSTL   ALSMX   RTIMP
         0    0.00    0.00    1.00    0.00    0.00    1.00    1.00     .05    0.00    0.00

                             UNIT HYDROGRAPH DATA
                       TP=  2.97     CP= .75     NTA=  0
                                                             BASEFLOW PARAMETERS
                               RECESSION DATA                (G.E.)
                   STRTQ=   -1.50    QRCSN=    -.05    RTIOR= 2.00
APPROXIMATE CLARK COEFFICIENTS FROM GIVEN SNYDER CP AND TP ARE TC=21.28 AND R=10.74 INTERVALS

     UNIT HYDROGRAPH 69 END-OF-PERIOD ORDINATES, LAG=   2.95 HOURS, CP=  .74  VOL= 1.00
       10.     37.     75.    120.    169.    220.    273.    328.    383.    438.
      492.    543.    585.    619.    644.    661.    671.    672.    666.    652.
      626.    585.    535.    487.    444.    404.    368.    336.    306.    278.
      254.    231.    211.    192.    175.    159.    145.    132.    120.    110.
      100.     91.     83.     76.     69.     63.     57.     52.     47.     43.
       39.     36.     33.     30.     27.     25.     23.     21.     19.     17.
       16.     14.     13.     12.     11.     10.      9.      8.      7.

      0                             END-OF-PERIOD FLOW
MO.DA  HR.MN  PERIOD   RAIN   EXCS   LOSS   COMP Q     MO.DA  HR.MN  PERIOD   RAIN   EXCS   LOSS    COMP Q
                                                                     SUM     27.00  24.59   2.41   365687.
                                                                          ( 686.)( 624.)(  61.)(10355.10)
```

SUBJECT: DAM SAFETY INSPECTION
WOHELO LAKE DAM

BY: WJV DATE: 7-29-80 PROJ. NO.: 79-203-326
CHKD. BY: DJS DATE: 7-29-80 SHEET NO.: B OF L

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RESERVOIR INFLOW HYDROGRAPHS

0.40 PMF

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	4037.	2962.	978.	507.	146046.
CMS	114.	84.	28.	14.	4136.
INCHES		6.89	9.10	9.43	9.43
MM		174.94	231.16	239.64	239.64
AC-FT		1469.	1941.	2012.	2012.
THOUS CU M		1811.	2394.	2481.	2481.

0.50 PMF

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	5047.	3702.	1223.	634.	182558.
CMS	143.	105.	35.	18.	5169.
INCHES		8.61	11.38	11.79	11.79
MM		218.68	288.95	299.55	299.55
AC-FT		1836.	2426.	2515.	2515.
THOUS CU M		2264.	2992.	3102.	3102.

PMF

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	10093.	7404.	2446.	1268.	365116.
CMS	286.	210.	69.	36.	10339.
INCHES		17.22	22.75	23.59	23.59
MM		437.35	577.91	599.09	599.09
AC-FT		3671.	4851.	5029.	5029.
THOUS CU M		4529.	5984.	6203.	6203.

********** ********** ********** ********** **********

HYDROGRAPH ROUTING

ROUTE THROUGH RESERVOIR

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
101	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	-970.	-1

STAGE	970.00	971.00	972.00	973.00	974.00	975.00	976.00	977.00	978.00
	979.80	980.00	980.30	981.00	981.20	981.30	981.60	982.00	983.00
FLOW	0.00	110.00	330.00	610.00	940.00	1330.00	1780.00	2280.00	2840.00
	3960.00	4090.00	4310.00	4830.00	4990.00	5090.00	5490.00	6110.00	9380.00

SURFACE AREA=	0.	4.	9.	9.	20.
CAPACITY=	0.	22.	82.	85.	364.
ELEVATION =	953.	970.	980.	980.	1000.

CREL	SPWID	COQW	EXPW	ELEVL	COQL	CAREA	EXPL
970.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COQD	EXPD	DAMWID
980.3	0.0	0.0	0.

SUBJECT DAM SAFETY INSPECTION

WOHELO LAKE DAM

BY WJV DATE 7-29-90 PROJ. NO. 79-203-32

CHKD. BY DJS DATE 7-29-80 SHEET NO. C OF L

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RESERVOIR OUTFLOW HYDROGRAPHS

PEAK OUTFLOW IS 4025. AT TIME 42.50 HOURS

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	4025.	2958.	973.	504.	145226.
CMS	114.	84.	28.	14.	4112.
INCHES		6.88	9.05	9.38	9.38
MM		174.73	229.92	238.29	238.29
AC-FT		1467.	1930.	2000.	2000.
THOUS CU M		1809.	2381.	2467.	2467.

0.40 PMF

PEAK OUTFLOW IS 5040. AT TIME 42.50 HOURS

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	5040	3698.	1217.	651.	181588.
CMS	143.	105.	34.	18.	5142.
INCHES		8.60	11.32	11.73	11.73
MM		218.43	287.50	297.95	297.95
AC-FT		1834.	2413.	2501.	2501.
THOUS CU M		2262.	2977.	3085.	3085.

0.50 PMF

PEAK OUTFLOW IS 10097. AT TIME 42.50 HOURS

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	10097.	7396.	2436.	1262.	363469.
CMS	286.	209.	69.	36.	10292.
INCHES		17.20	22.66	23.48	23.48
MM		436.90	575.48	596.39	596.39
AC-FT		3668.	4831.	5006.	5006.
THOUS CU M		4524.	5959.	6175.	6175.

PMF

********** ********** ********** ********** **********

HYDROGRAPH ROUTING

ROUTE FROM DAM TO SECTION 2, 4820 FT D.S. FROM DAM

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
102	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	-1.	0

NORMAL DEPTH CHANNEL ROUTING

QN(1)	QN(2)	QN(3)	ELNVT	ELMAX	RLNTH	SEL
.1000	.0400	.0800	782.0	820.0	4820.	.04300

CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC
0.00 820.00 50.00 800.00 180.00 800.00 180.00 782.00 187.00 782.00
187.00 800.00 250.00 800.00 330.00 820.00

STORAGE	0.00	1.55	3.10	4.65	6.20	7.75	9.29	10.84	12.39
	59.64	108.22	159.67	214.00	271.21	331.29	394.25	460.09	528.81
OUTFLOW	0.00	127.00	327.89	550.52	782.87	1020.43	1261.11	1503.81	1747.89
	4445.29	9436.43	16468.92	25383.26	36108.79	48615.41	62895.36	78954.51	96607.62
STAGE	782.00	784.00	786.00	788.00	790.00	792.00	794.00	796.00	798.00
	802.00	804.00	806.00	808.00	810.00	812.00	814.00	816.00	818.00
FLOW	0.00	127.00	327.89	550.52	782.87	1020.43	1261.11	1503.81	1747.89
	4445.29	9436.43	16468.92	25383.26	36108.79	48615.41	62895.36	78954.51	96607.62

SUBJECT DAM SAFETY INSPECTION

WOHELO LAKE DAM

BY WJV DATE 7-29-80 PROJ. NO. 79-203-326

CHKD. BY DJS DATE 7-29-80 SHEET NO. D OF L

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  **********         **********         **********         **********         **********

                                  HYDROGRAPH ROUTING

                    ROUTE FROM SECTION 2 TO SECTION 3, 6660 FT D.S. FROM DAM

                        ISTAQ    ICOMP    IECON    ITAPE     JPLT     JPRT    INAME   ISTAGE    IAUTO
                          203        1        0        0        0        0        1        0        0
                                                 ROUTING DATA
               QLOSS    CLOSS      AVG     IRES    ISAME     IOPT     IPMP              LSTR
                 0.0    0.000     0.00        1        1        0        0                 0
NORMAL DEPTH CHANNEL ROUTING
----------------------------    NSTPS    NSTDL      LAG    AMSKK        X      TSK    STORA   ISPRAT
                                    1        0        0    0.000    0.000    0.000      -1.        0

        QN(1)    QN(2)    QN(3)    ELNVT    ELMAX    RLNTH      SEL
        .0800    .0350    .0800    747.0    780.0    1840.   .02000


        CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC
            0.00  780.00  700.00  760.00 1267.00  750.00 1270.00  747.00 1290.00  747.00
         1293.00  750.00 1480.00  760.00 1620.00  780.00

STORAGE        0.00        1.59        3.79       13.12       32.06       60.61       98.77      146.53      203.33
             334.00      407.36      486.00      570.14      659.56      754.33      854.45      959.92     1070.74
OUTFLOW        0.00      299.88      993.70     2575.47     5855.28    11485.42    20025.19    31980.44    48545.97
           94979.27   124328.46   157946.65   195981.05   238583.23   285906.96   338106.86   395337.58   457753.25

STAGE        747.00      748.74      750.47      752.21      753.95      755.68      757.42      759.16      760.89
             764.37      766.11      767.84      769.58      771.32      773.05      774.79      776.53      778.26

FLOW           0.00      299.88      993.70     2575.47     5855.28    11485.42    20025.19    31980.44    48545.97
           94979.27   124328.46   157946.65   195981.05   238583.23   285906.96   338106.86   395337.58   457753.25
          **********         **********         **********         **********         **********
                                  HYDROGRAPH ROUTING

                   ROUTE FROM SECTION 3 TO SECTION 4, 10440 FT D.S. FROM DAM

                        ISTAQ    ICOMP    IECON    ITAPE     JPLT     JPRT    INAME   ISTAGE    IAUTO
                          304        1        0        0        0        0        1        0        0
                                                 ROUTING DATA
               QLOSS    CLOSS      AVG     IRES    ISAME     IOPT     IPMP              LSTR
                 0.0    0.000     0.00        1        1        0        0                 0

                        NSTPS    NSTDL      LAG    AMSKK        X      TSK    STORA   ISPRAT
NORMAL DEPTH CHANNEL ROUTING        1        0        0    0.000    0.000    0.000      -1.        0
----------------------------
        QN(1)    QN(2)    QN(3)    ELNVT    ELMAX    RLNTH      SEL
        .0900    .0350    .0900    690.0    720.0    3780.   .01400
        CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC
            0.00  720.00 1200.00  708.00 1788.00  702.00 1788.00  690.00 1800.00  690.00
         1800.00  702.00 1900.00  711.00 2000.00  720.00

STORAGE        0.00        1.64        3.29        4.93        6.58        8.22        9.87       11.51       15.04
              84.42      154.53      248.31      366.09      507.92      673.78      863.68     1077.61     1315.59
OUTFLOW        0.00      110.75      309.93      547.89      807.61     1080.92     1363.33     1652.14     2010.64
            8236.88     9331.76    15727.43    24872.78    37185.80    53048.24    72821.97    96852.62   125472.17

STAGE        690.00      691.58      693.16      694.74      696.32      697.89      699.47      701.05      702.63
             705.79      707.37      708.95      710.53      712.11      713.68      715.26      716.84      718.42

FLOW           0.00      110.75      309.93      547.89      807.61     1080.92     1363.33     1652.14     2010.64
            8236.88     9331.76    15727.43    24872.78    37185.80    53048.24    72821.97    96852.62   125472.17
```

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SUMMARY OF DAM SAFETY ANALYSIS

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	970.00	970.00	980.30
STORAGE	22.	22.	85.
OUTFLOW	0.	0.	4310.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.30	978.30	0.00	68.	3019.	0.00	42.50	0.00
.40	979.90	0.00	81.	4025.	0.00	42.50	0.00
.50	981.25	.95	93.	5040.	2.17	42.50	0.00
.60	981.96	1.66	100.	6053.	3.33	42.50	0.00
1.00	983.16	2.86	112.	10097.	5.67	42.50	0.00

OVERTOPPING OCCURS @ ≈ 0.43 PMF

PLAN 1 STATION 102

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.30	3002.	800.8	42.83
.40	4003.	801.6	42.83
.50	5032.	802.2	42.67
.60	6043.	802.6	42.67
1.00	10087.	804.2	42.50

SECTION 2
@ ≈ 4820 FT
D.S. FROM DAM

PLAN 1 STATION 203

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.30	3001.	752.4	42.83
.40	4001.	753.0	42.83
.50	5025.	753.5	42.67
.60	6047.	754.0	42.67
1.00	10079.	755.3	42.67

SECTION 3
@ ≈ 6660 FT
D.S. FROM DAM

PLAN 1 STATION 304

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.30	2972.	704.2	43.17
.40	3960.	704.9	43.17
.50	4987.	705.6	43.00
.60	6008.	706.1	42.83
1.00	10041.	707.5	42.83

SECTION 4
@ ≈ 10440 FT
D.S. FROM DAM

SUBJECT DAM SAFETY INSPECTION

WOHELO LAKE DAM

BY WJV DATE 7-29-80 PROJ. NO. 79-203-326

CHKD. BY DJS DATE 7-29-80 SHEET NO. F OF L

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BREACHING ANALYSIS

(INPUT SAME AS FOR OVERTOPPING ANALYSIS, WITH THE ADDITION OF THE BREACH DATA GIVEN HERE)

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DAM SAFETY INSPECTION
WOHELO LAKE DAM ***** BREACHING ANALYSIS *****
10-MINUTE TIME STEP AND 48-HOUR STORM DURATION

                         JOB SPECIFICATION
   NQ    NHR   NMIN   IDAY    IHR   IMIN  METRC   IPLT   IPRT  NSTAN
  288      0     10      0      0      0      0      0      0      0
                      JOPER    NWT  LROPT  TRACE
                          5      0      0      0

                MULTI-PLAN ANALYSES TO BE PERFORMED
                  NPLAN= 5 NRTIO= 1 LRTIO= 1
RTIOS=   .45

*********      *********      *********      *********      *********

                       HYDROGRAPH ROUTING

ROUTE THROUGH RESERVOIR

            ISTAQ  ICOMP  IECON  ITAPE   JPLT   JPRT  INAME ISTAGE  IAUTO
              101      1      0      0      0      0      1      0      0

                       ALL PLANS HAVE SAME
                          ROUTING DATA
       QLOSS  CLOSS    AVG   IRES  ISAME   IOPT   IPMP          LSTR
         0.0  0.000   0.00      1      1      0      0             0

            NSTPS  NSTDL    LAG  AMSKK      X    TSK   STORA  ISPRAT
                1      0      0  0.000  0.000  0.000   -970.     -1

STAGE     970.00   971.00   972.00   973.00   974.00   975.00   976.00   977.00   978.00
          979.80   980.00   980.30   981.00   981.20   981.30   981.60   982.00   983.00

FLOW        0.00   110.00   330.00   610.00   940.00  1330.00  1780.00  2280.00  2840.00
         3960.00  4090.00  4310.00  4830.00  4990.00  5090.00  5490.00  6110.00  9380.00

SURFACE AREA=     0.       4.       9.       9.      20.

    CAPACITY=     0.      22.      82.      85.     364.

   ELEVATION=   953.     970.     980.     980.    1000.

        CREL   SPWID   COQW   EXPW   ELEVL   COQL   CAREA   EXPL
       970.0     0.0    0.0    0.0     0.0    0.0     0.0    0.0

                             DAM DATA
                    TOPEL   COQD   EXPD  DAMWID
                    980.3    0.0    0.0      0.
```

SUBJECT DAM SAFETY INSPECTION
WOHELO LAKE DAM

BY WJV DATE 7-29-80 PROJ. NO. 79-203-326
CHKD. BY ZCS DATE 7-29-80 SHEET NO. G OF L

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PLAN 1

```
                    DAM BREACH DATA
      BRWID      Z     ELBM     TFAIL     WSEL    FAILEL
        0.     1.00   953.00      .50    970.00   980.30

              STATION    101. PLAN 1. RATIO 1

BEGIN DAM FAILURE AT 42.00 HOURS       PEAK OUTFLOW IS     6755. AT TIME  42.50 HOURS
```

PLAN 2

```
                    DAM BREACH DATA
      BRWID      Z     ELBM     TFAIL     WSEL    FAILEL
      300.     4.00   953.00      .50    970.00   980.30

              STATION    101. PLAN 2. RATIO 1

BEGIN DAM FAILURE AT 42.00 HOURS       PEAK OUTFLOW IS     8300. AT TIME  42.12 HOURS
```

PLAN 3

```
                    DAM BREACH DATA
      BRWID      Z     ELBM     TFAIL     WSEL    FAILEL
        0.     1.00   953.00     4.00    970.00   980.30

              STATION    101. PLAN 3. RATIO 1

BEGIN DAM FAILURE AT 42.00 HOURS       PEAK OUTFLOW IS     4570. AT TIME  42.67 HOURS
```

PLAN 4

```
                    DAM BREACH DATA
      BRWID      Z     ELBM     TFAIL     WSEL    FAILEL
      300.     4.00   953.00     4.00    970.00   980.30

              STATION    101. PLAN 4. RATIO 1

BEGIN DAM FAILURE AT 42.00 HOURS       PEAK OUTFLOW IS     5026. AT TIME  42.50 HOURS
```

PLAN 5

```
                    DAM BREACH DATA
      BRWID      Z     ELBM     TFAIL     WSEL    FAILEL
      100.     1.00   953.00     2.00    970.00   980.30

              STATION    101. PLAN 5. RATIO 1

BEGIN DAM FAILURE AT 42.00 HOURS       PEAK OUTFLOW IS     5311. AT TIME  42.50 HOURS
```

SUBJECT DAM SAFETY INSPECTION

WOHELO LAKE DAM

BY WJV DATE 7-29-80 PROJ. NO. 79-203-326

CHKD. BY DSS DATE 7-29-80 SHEET NO. H OF L

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THE DAM BREACH HYDROGRAPH WAS DEVELOPED USING A TIME INTERVAL OF .010 HOURS DURING BREACH FORMATION.
DOWNSTREAM CALCULATIONS WILL USE A TIME INTERVAL OF .167 HOURS.
THIS TABLE COMPARES THE HYDROGRAPH FOR DOWNSTREAM CALCULATIONS WITH THE COMPUTED BREACH HYDROGRAPH.
INTERMEDIATE FLOWS ARE INTERPOLATED FROM END-OF-PERIOD VALUES.

TIME (HOURS)	TIME FROM BEGINNING OF BREACH (HOURS)	INTERPOLATED BREACH HYDROGRAPH (CFS)	-	COMPUTED BREACH HYDROGRAPH (CFS)	=	ERROR (CFS)	ACCUMULATED ERROR (CFS)	ACCUMULATED ERROR (AC-FT)
42.000	0.000	4371.		4371.		0.	0.	0.
42.010	.010	4592.		4767.		-175.	-175.	-0.
42.020	.020	4812.		5339.		-527.	-702.	-1.
42.029	.029	5032.		5941.		-909.	-1611.	-1.
42.039	.039	5252.		6505.		-1253.	-2864.	-2.
42.049	.049	5473.		7011.		-1538.	-4402.	-4.
42.059	.059	5693.		7431.		-1739.	-6141.	-5.
42.069	.069	5913.		7762.		-1849.	-7989.	-6.
42.078	.078	6133.		8011.		-1878.	-9867.	-8.
42.088	.088	6353.		8194.		-1840.	-11707.	-9.
42.098	.098	6574.		8306.		-1732.	-13440.	-11.
42.108	.108	6794.		8370.		-1576.	-15016.	-12.
42.118	.118	7014.		8388.		-1374.	-16390.	-13.
42.127	.127	7234.		8374.		-1140.	-17530.	-14.
42.137	.137	7455.		8338.		-884.	-18414.	-15.
42.147	.147	7675.		8277.		-602.	-19016.	-15.
42.157	.157	7895.		8205.		-310.	-19326.	-16.
42.167	.167	8115.		8115.		0.	-19326.	-16.
42.176	.176	7993.		8026.		-33.	-19360.	-16.
42.186	.186	7871.		7922.		-52.	-19412.	-16.
42.196	.196	7748.		7823.		-74.	-19486.	-16.
42.206	.206	7626.		7710.		-84.	-19570.	-16.
42.216	.216	7504.		7600.		-97.	-19667.	-16.
42.225	.225	7381.		7484.		-103.	-19770.	-16.
42.235	.235	7259.		7373.		-114.	-19883.	-16.
42.245	.245	7137.		7269.		-132.	-20015.	-16.
42.255	.255	7014.		7170.		-156.	-20171.	-16.
42.265	.265	6892.		7078.		-186.	-20357.	-16.
42.275	.275	6770.		6964.		-195.	-20552.	-17.
42.284	.284	6647.		6821.		-174.	-20726.	-17.
42.294	.294	6525.		6663.		-138.	-20864.	-17.
42.304	.304	6403.		6501.		-98.	-20962.	-17.
42.314	.314	6280.		6340.		-60.	-21022.	-17.
42.324	.324	6158.		6184.		-26.	-21048.	-17.
42.333	.333	6036.		6036.		0.	-21048.	-17.
42.343	.343	5952.		5894.		58.	-20990.	-17.
42.353	.353	5868.		5759.		109.	-20881.	-17.
42.363	.363	5785.		5632.		152.	-20728.	-17.
42.373	.373	5701.		5513.		188.	-20541.	-17.
42.382	.382	5618.		5402.		215.	-20325.	-16.
42.392	.392	5534.		5299.		235.	-20090.	-16.
42.402	.402	5450.		5202.		248.	-19842.	-16.
42.412	.412	5367.		5114.		253.	-19589.	-16.
42.422	.422	5283.		5032.		251.	-19337.	-16.
42.431	.431	5200.		4957.		242.	-19095.	-15.
42.441	.441	5116.		4889.		227.	-18869.	-15.
42.451	.451	5032.		4828.		204.	-18664.	-15.
42.461	.461	4949.		4773.		176.	-18488.	-15.
42.471	.471	4865.		4724.		141.	-18348.	-15.
42.480	.480	4781.		4682.		100.	-18248.	-15.
42.490	.490	4698.		4645.		53.	-18195.	-15.
42.500	.500	4614.		4614.		0.	-18195.	-15.

PLAN 2

SUBJECT DAM SAFETY INSPECTION

WOHELO LAKE DAM

BY WJV DATE 7-29-80 PROJ. NO. 79-203-326

CHKD. BY [illegible] DATE 7-29-80 SHEET NO. I OF L

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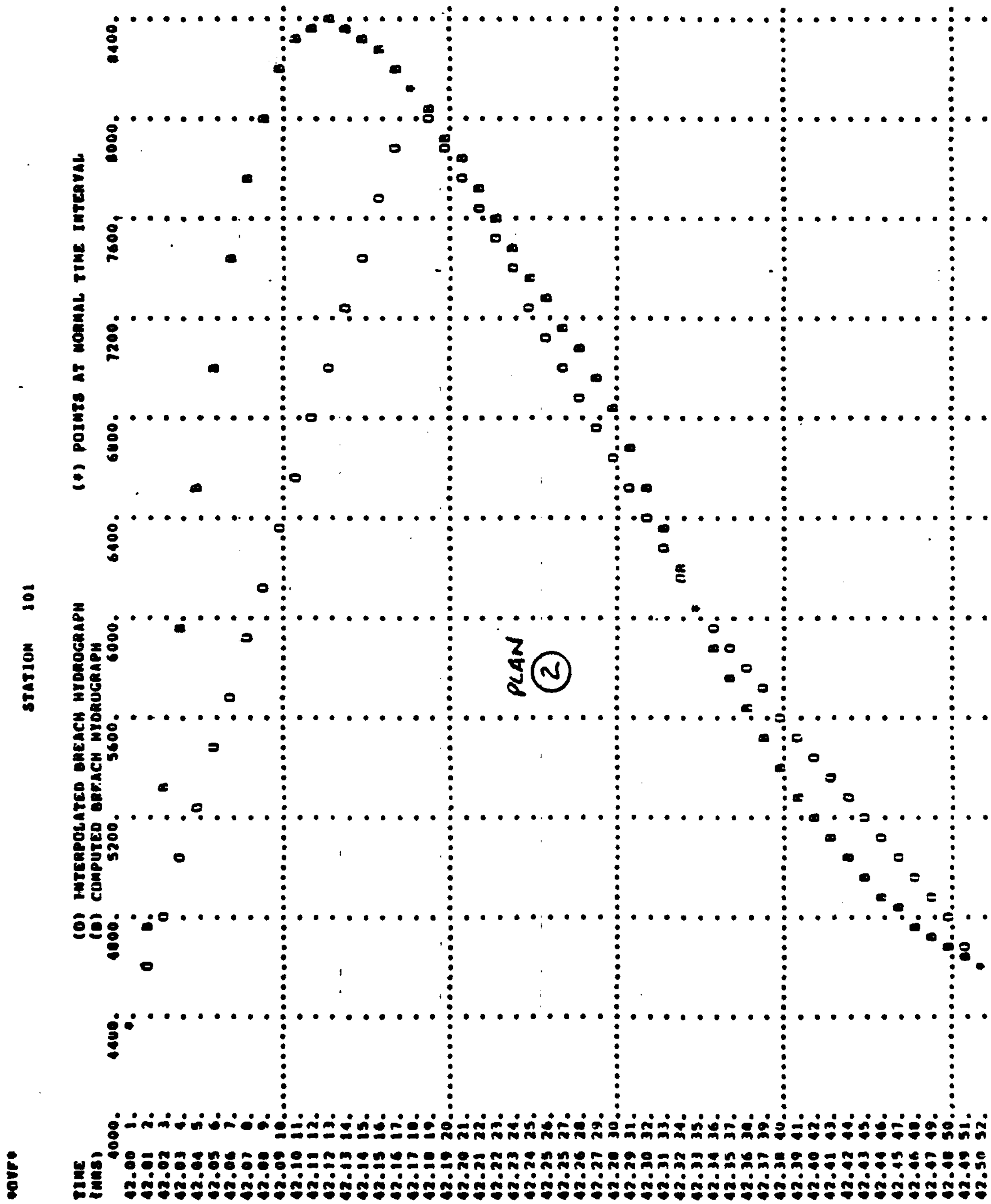

SUBJECT DAM SAFETY INSPECTION
• WOHELO LAKE DAM

BY WJV DATE 7-29-80 PROJ. NO. 79-203-326
CHKD. BY DSS DATE 7-29-80 SHEET NO. J OF L

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THE DAM BREACH HYDROGRAPH WAS DEVELOPED USING A TIME INTERVAL OF .042 HOURS DURING BREACH FORMATION.
DOWNSTREAM CALCULATIONS WILL USE A TIME INTERVAL OF .167 HOURS.
THIS TABLE COMPARES THE HYDROGRAPH FOR DOWNSTREAM CALCULATIONS WITH THE COMPUTED BREACH HYDROGRAPH.
INTERMEDIATE FLOWS ARE INTERPOLATED FROM END-OF-PERIOD VALUES.

PLAN 5

TIME (HOURS)	TIME FROM BEGINNING OF BREACH (HOURS)	INTERPOLATED BREACH HYDROGRAPH (CFS)	-	COMPUTED BREACH HYDROGRAPH (CFS)	=	ERROR (CFS)	ACCUMULATED ERROR (CFS)	ACCUMULATED ERROR (AC-FT)
42.000	0.000	4366.		4366.		0.	0.	0.
42.042	.042	4523.		4522.		1.	1.	0.
42.083	.083	4680.		4707.		-26.	-26.	-0.
42.125	.125	4838.		4868.		-30.	-56.	-0.
42.167	.167	4995.		4995.		0.	-56.	-0.
42.208	.208	5061.		5101.		-39.	-95.	-0.
42.250	.250	5127.		5176.		-48.	-144.	-0.
42.292	.292	5193.		5226.		-33.	-176.	-1.
42.333	.333	5259.		5259.		0.	-176.	-1.
42.375	.375	5272.		5289.		-17.	-193.	-1.
42.417	.417	5285.		5302.		-17.	-210.	-1.
42.458	.458	5298.		5305.		-7.	-218.	-1.
42.500	.500	5311.		5311.		0.	-218.	-1.
42.542	.542	5301.		5305.		-4.	-222.	-1.
42.583	.583	5291.		5296.		-4.	-226.	-1.
42.625	.625	5281.		5289.		-8.	-234.	-1.
42.667	.667	5271.		5271.		0.	-234.	-1.
42.708	.708	5248.		5257.		-8.	-242.	-1.
42.750	.750	5226.		5231.		-5.	-247.	-1.
42.792	.792	5203.		5205.		-2.	-249.	-1.
42.833	.833	5181.		5181.		0.	-249.	-1.
42.875	.875	5143.		5145.		-2.	-251.	-1.
42.917	.917	5106.		5114.		-8.	-259.	-1.
42.958	.958	5069.		5069.		1.	-258.	-1.
43.000	1.000	5032.		5032.		0.	-258.	-1.
43.042	1.042	4985.		4979.		6.	-251.	-1.
43.083	1.083	4938.		4935.		3.	-248.	-1.
43.125	1.125	4891.		4876.		15.	-233.	-1.
43.167	1.167	4844.		4844.		0.	-233.	-1.
43.208	1.208	4776.		4791.		-14.	-248.	-1.
43.250	1.250	4708.		4743.		-34.	-282.	-1.
43.292	1.292	4641.		4662.		-22.	-303.	-1.
43.333	1.333	4573.		4573.		0.	-303.	-1.
43.375	1.375	4483.		4481.		2.	-302.	-1.
43.417	1.417	4394.		4391.		3.	-298.	-1.
43.458	1.458	4304.		4302.		3.	-296.	-1.
43.500	1.500	4215.		4215.		0.	-296.	-1.
43.542	1.542	4133.		4130.		3.	-293.	-1.
43.583	1.583	4051.		4047.		4.	-288.	-1.
43.625	1.625	3969.		3966.		3.	-285.	-1.
43.667	1.667	3887.		3887.		0.	-285.	-1.
43.708	1.708	3814.		3811.		3.	-282.	-1.
43.750	1.750	3740.		3736.		4.	-278.	-1.
43.792	1.792	3666.		3663.		3.	-275.	-1.
43.833	1.833	3592.		3592.		0.	-275.	-1.
43.875	1.875	3526.		3523.		3.	-272.	-1.
43.917	1.917	3460.		3456.		4.	-268.	-1.
43.958	1.958	3394.		3391.		3.	-265.	-1.
44.000	2.000	3328.		3328.		0.	-265.	-1.

SUBJECT DAM SAFETY INSPECTION

WOHELO LAKE DAM

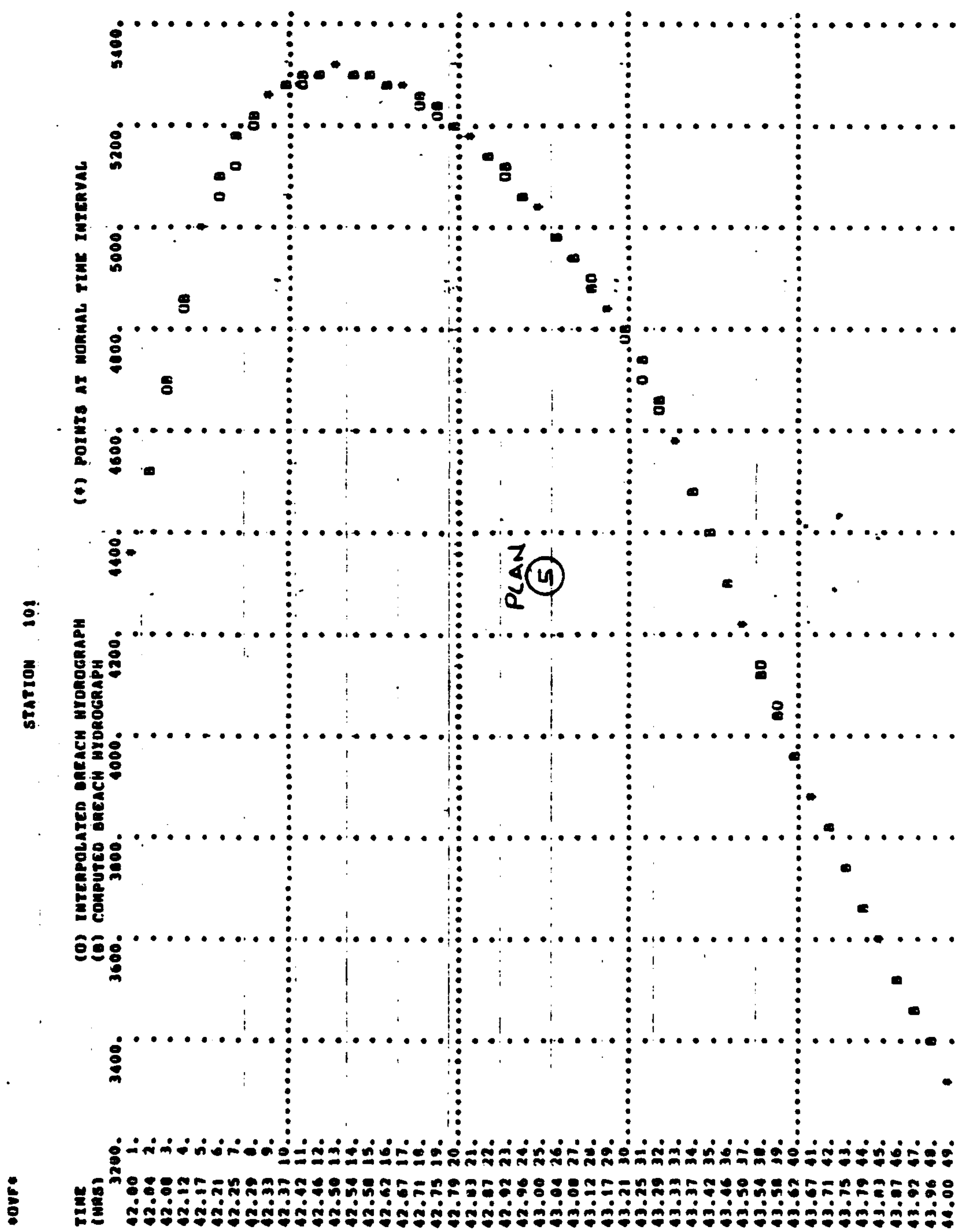
BY WJV DATE 7-29-80 PROJ. NO. 79-203-326

CHKD. BY DJS DATE 7-29-80 SHEET NO. K OF L

GAI CONSULTANTS

Engineers • Geologists • Plan

Environmental Specialists



SUBJECT DAM SAFETY INSPECTION

WONELO LAKE DAM

BY WJV DATE 7-29-80 PROJ. NO. 79-203-326

CHKD. BY DJS DATE 7-29-80 SHEET NO. 6 OF 6

CONSULTANTS

Engineers • Geologists • Plann
Environmental Specialists

SUMMARY OF DAM SAFETY ANALYSIS

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	970.00	970.00	980.30
STORAGE	22.	22.	85.
OUTFLOW	0.	0.	4310.

PLAN	RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
1	.45	980.41	.11	85.	6755.	.31	42.50	42.00
2	.45	980.36	.06	85.	8388.	.18	42.12	42.00
3	.45	980.55	.25	87.	4570.	1.00	42.67	42.00
4	.45	980.36	.06	85.	5026.	.25	42.50	42.00
5	.45	980.37	.07	85.	5311.	.25	42.50	42.00

STATION 102

SECTION 2

PLAN	RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
1	.45	6201.	802.7	42.50
2	.45	6848.	803.0	42.33
3	.45	4558.	802.0	42.83
4	.45	5005.	802.2	42.67
5	.45	5282.	802.3	42.67

STATION 203

SECTION 3

PLAN	RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
1	.45	5947.	754.0	42.67
2	.45	6442.	754.1	42.33
3	.45	4557.	753.3	42.83
4	.45	5004.	753.5	42.67
5	.45	5269.	753.6	42.67

STATION 304

SECTION 4

PLAN	RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
1	.45	5452.	705.9	42.83
2	.45	5709.	706.0	42.50
3	.45	4510.	705.3	43.17
4	.45	4911.	705.6	43.00
5	.45	5155.	705.7	43.00

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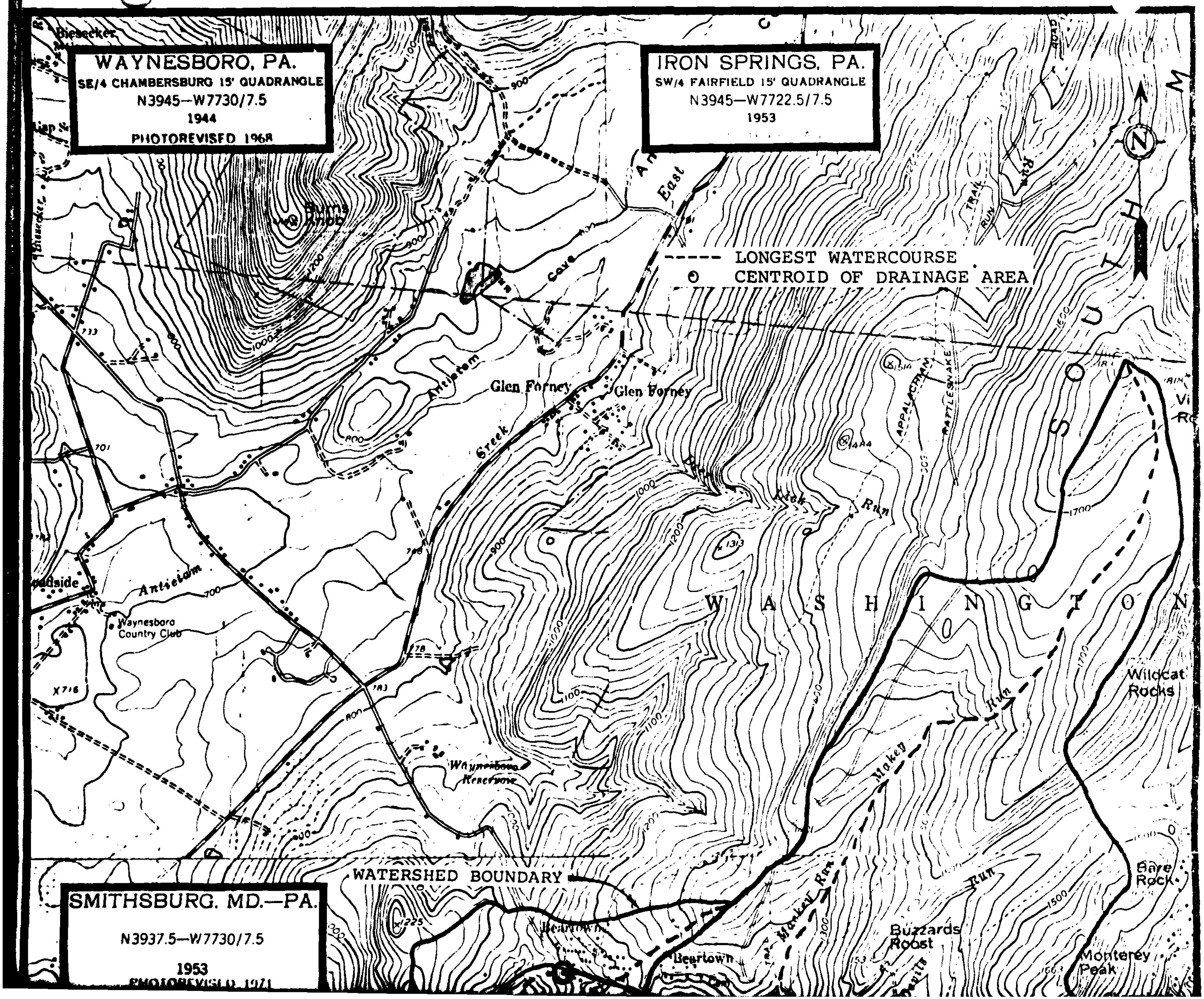
APPENDIX E

FIGURES

LIST OF FIGURES



WAYNESBORO, PA.
SE/4 CHAMBERSBURG 15' QUADRANGLE
N3945—W7730/7.5
1944
PHOTOREVISED 1968
IRON SPRINGS, PA.
SW/4 FAIRFIELD 15' QUADRANGLE
N3945—W7722.5/7.5
1953
LONGEST WATERCOURSE
CENTROID OF DRAINAGE AREA
SMITHSBURG, MD.—PA.
N3937.5—W7730/7.5
1953
WATERSHED BOUNDARY
WASHINGTON
Glen Forney
Waynesboro Country Club
Waynesboro Reservoir
Wildcat Rocks
Bare Rock
Monterey Peak
Buzzards Roost
Beartown
Antietam
Creek
Cove
East
Biesecker

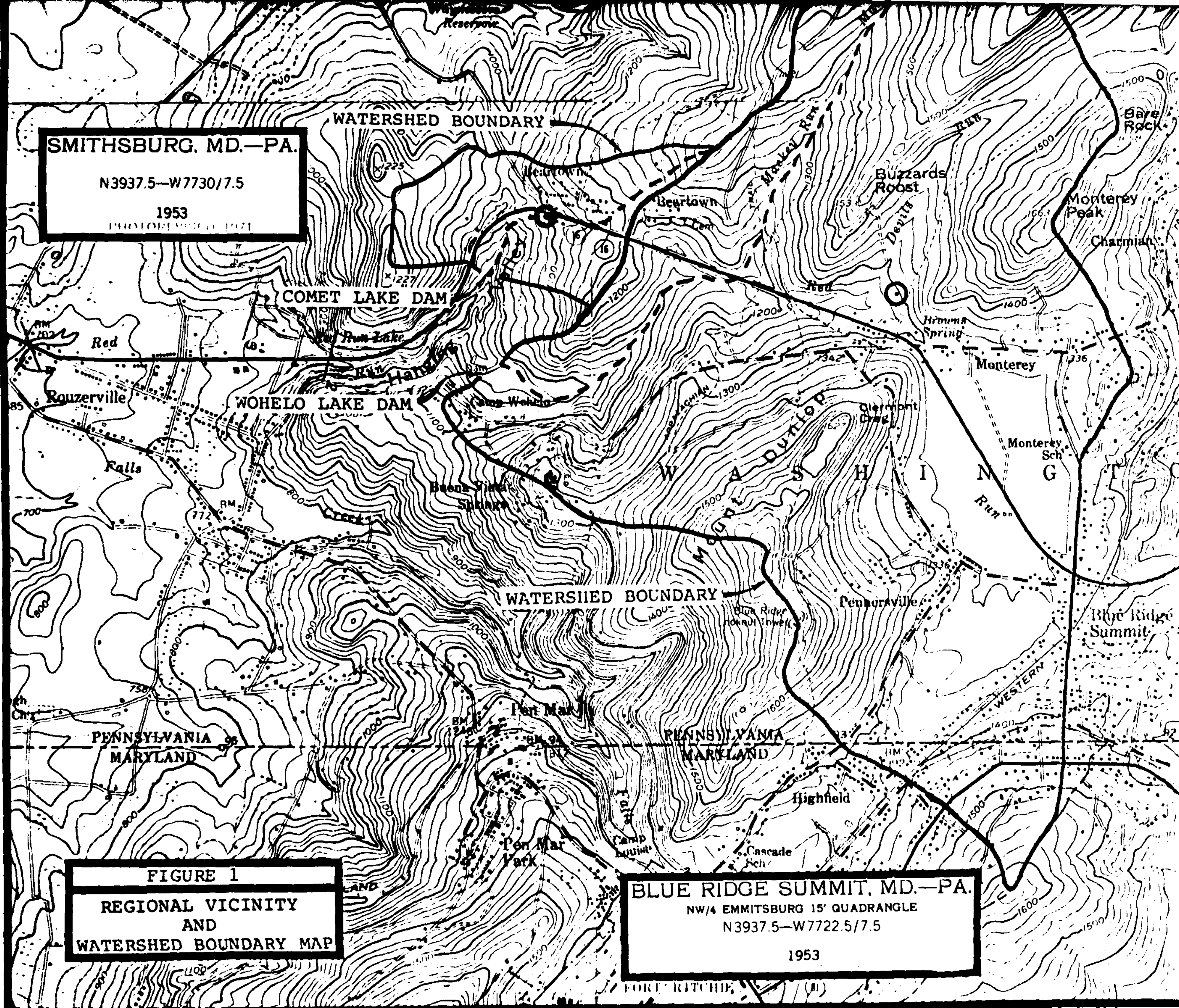
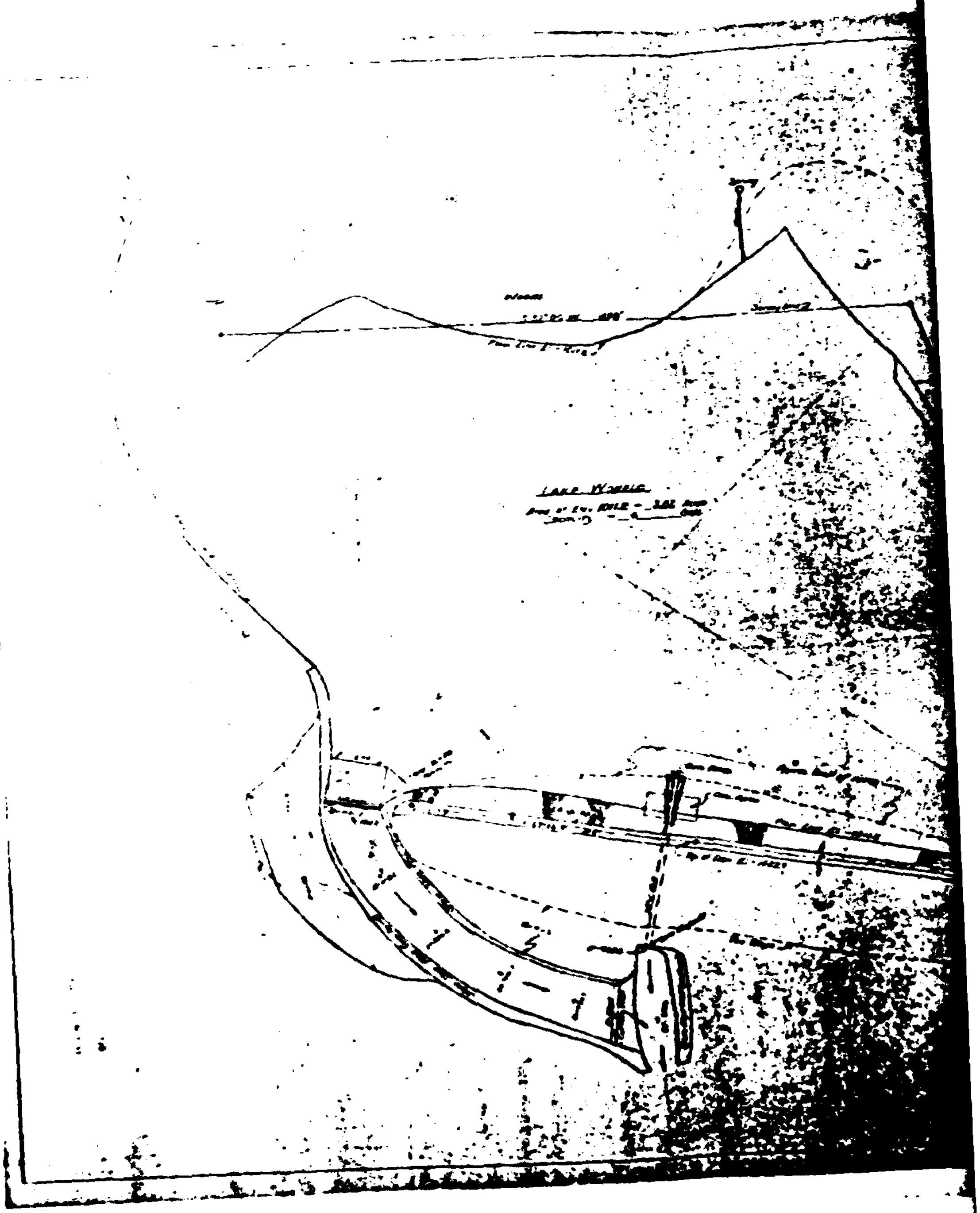
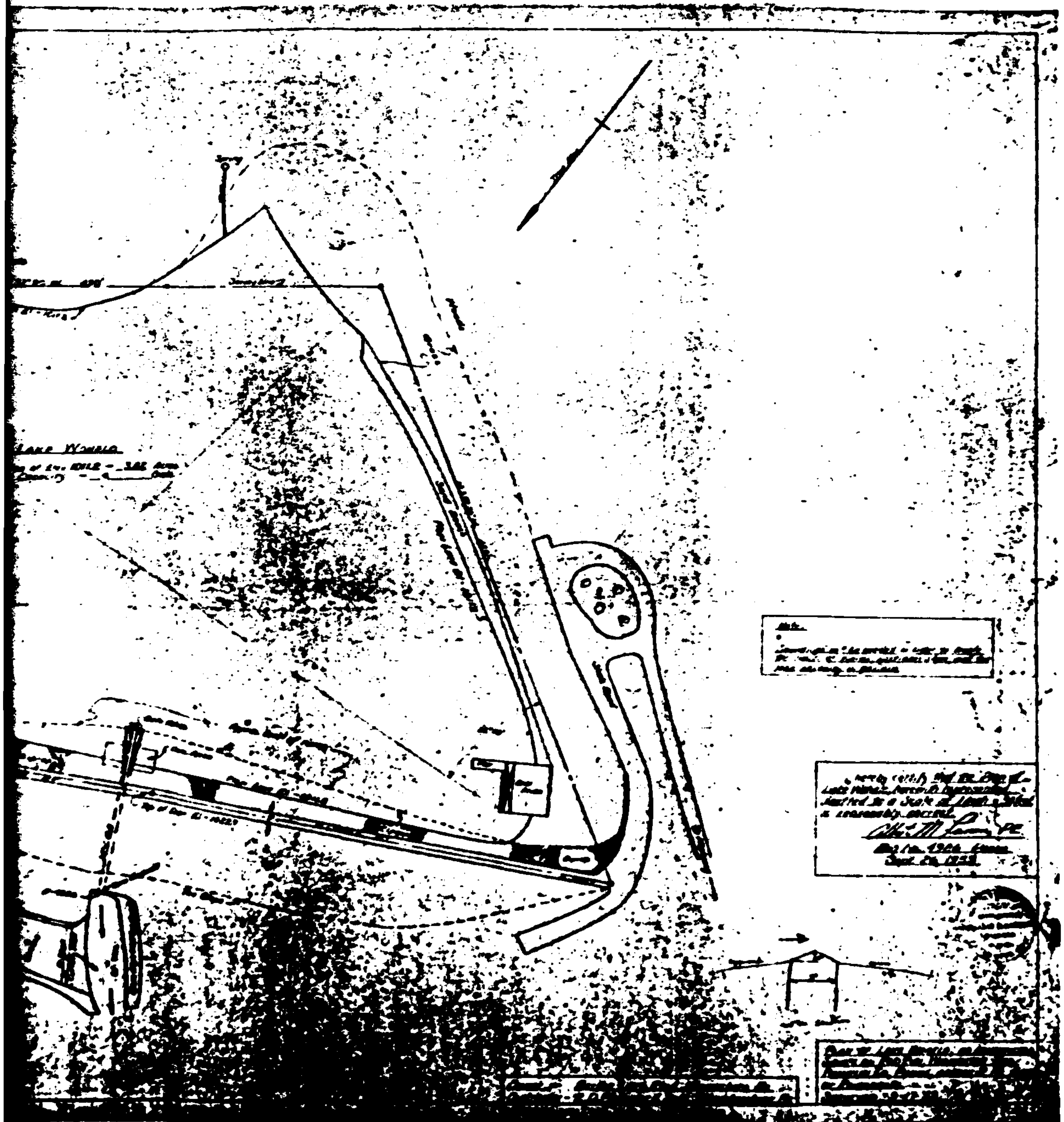


FIGURE 1

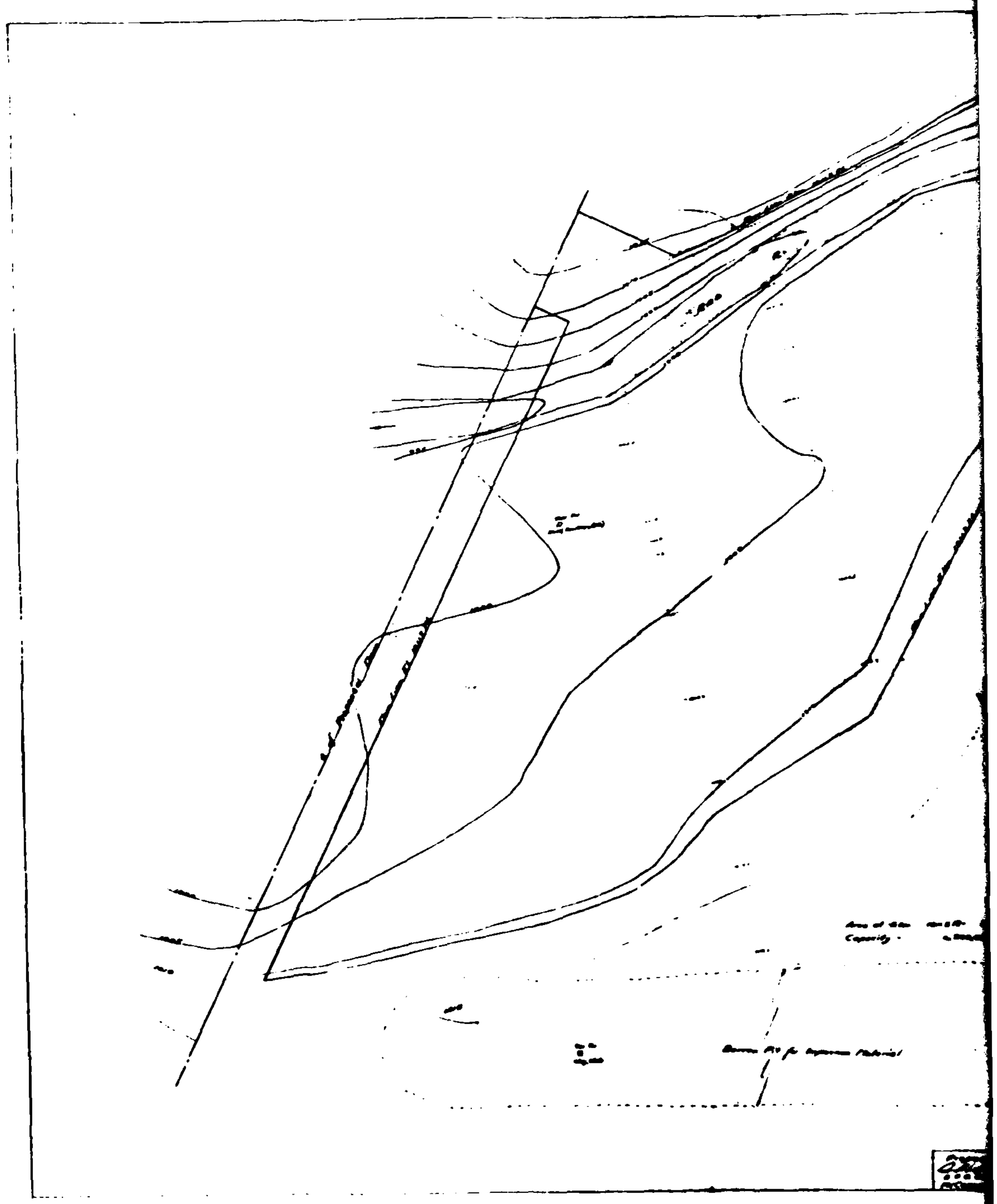
REGIONAL VICINITY AND WATERSHED BOUNDARY MAP


Woods



CONSULTANTS, INC.

FIGURE 2



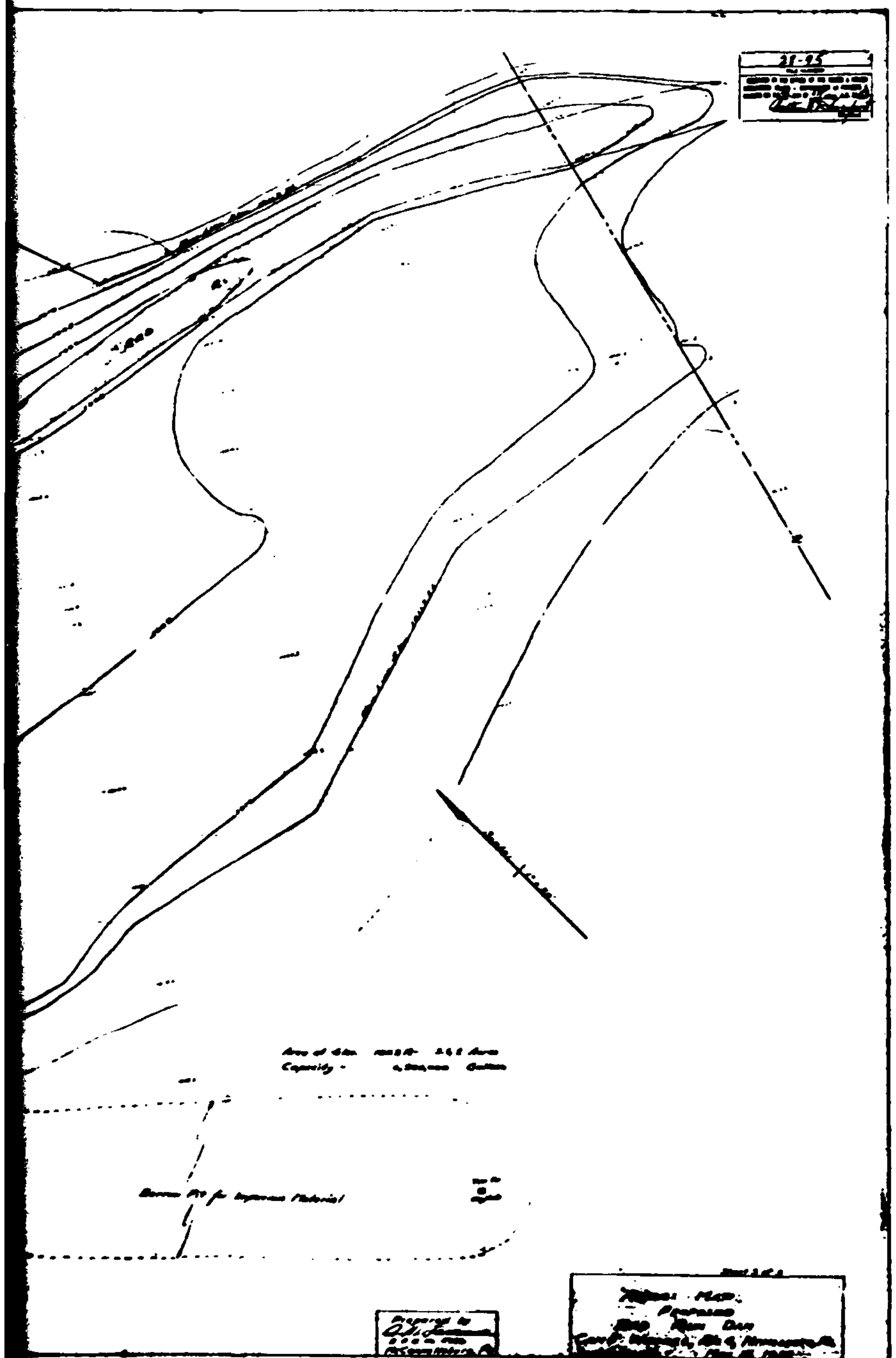


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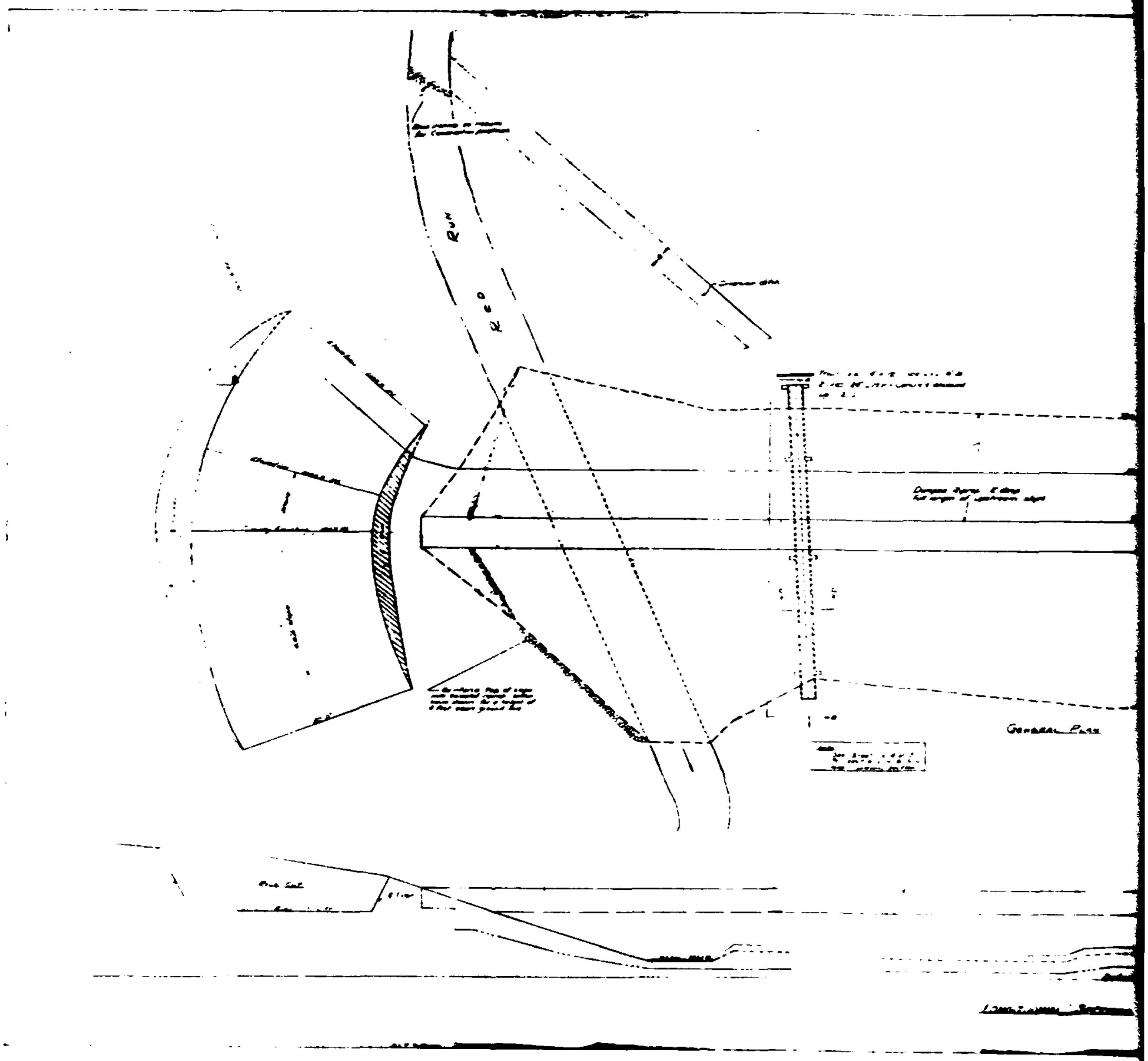
FIGURE 3


RUN
RED
GENERAL PLAN

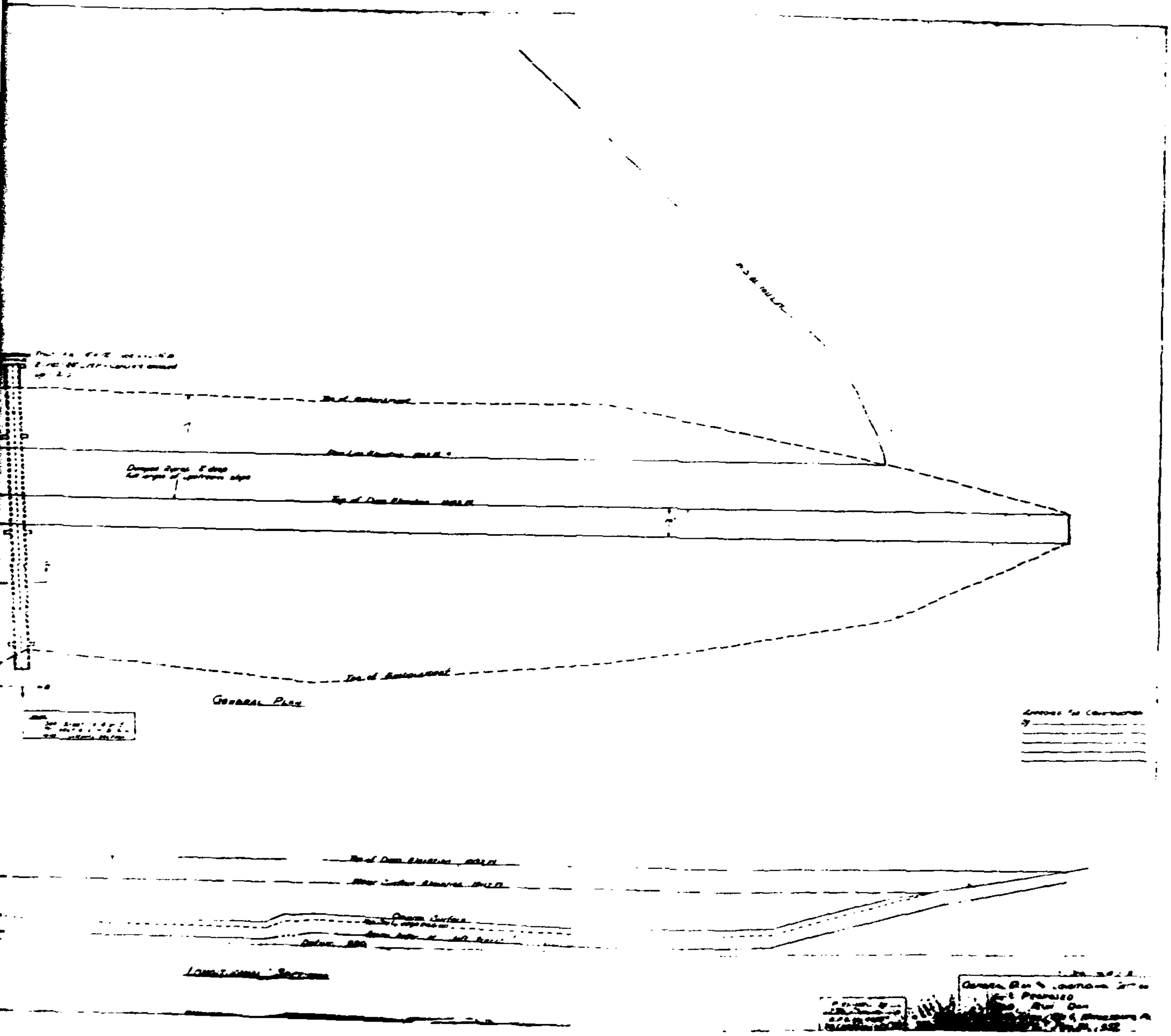


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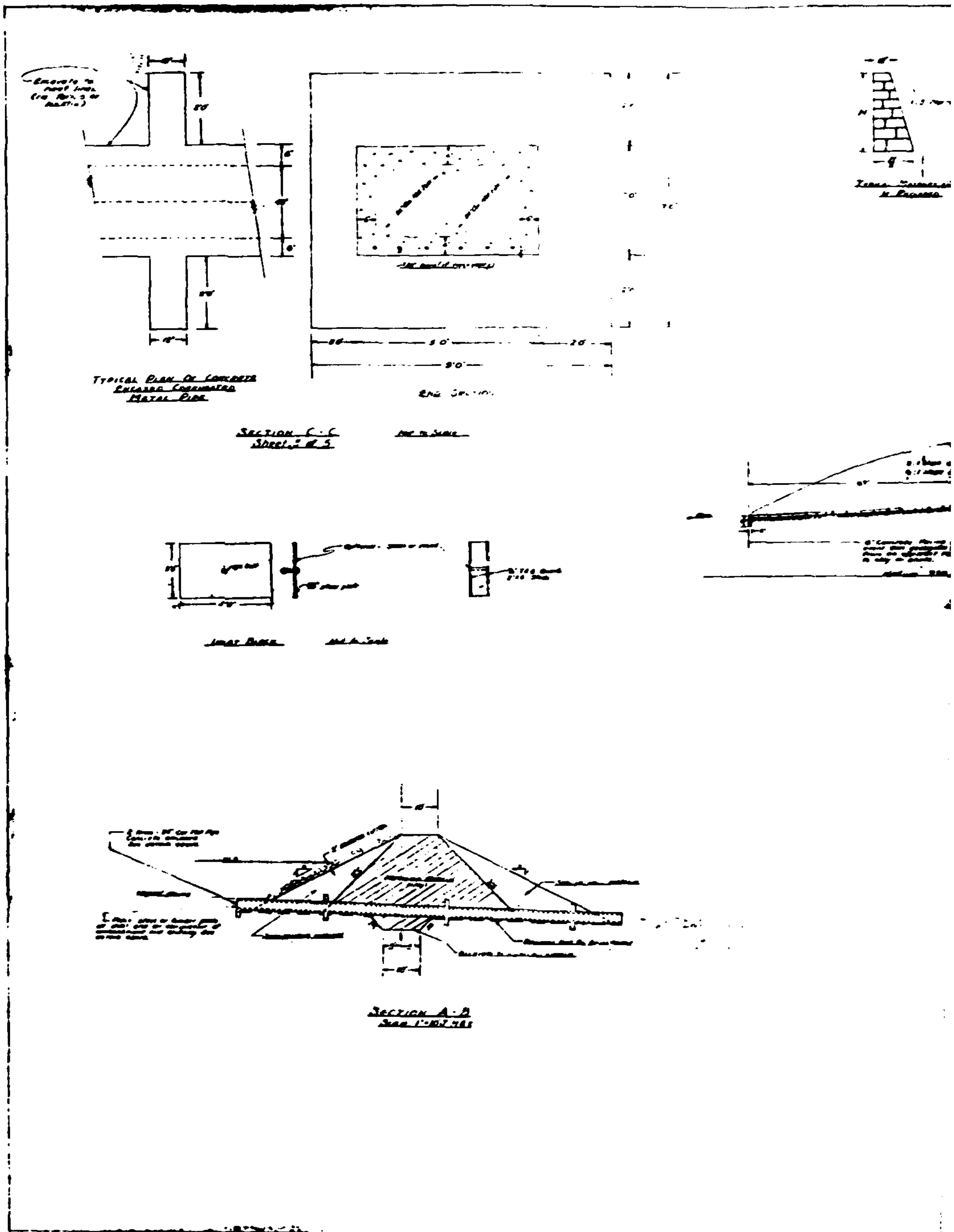
FIGURE 4

12



TYPICAL PLAN OF CONCRETE ENCASED CORRUGATED METAL PIPE
END SECTION
SECTION C-C
Sheet 2 of 5
SECTION A-B

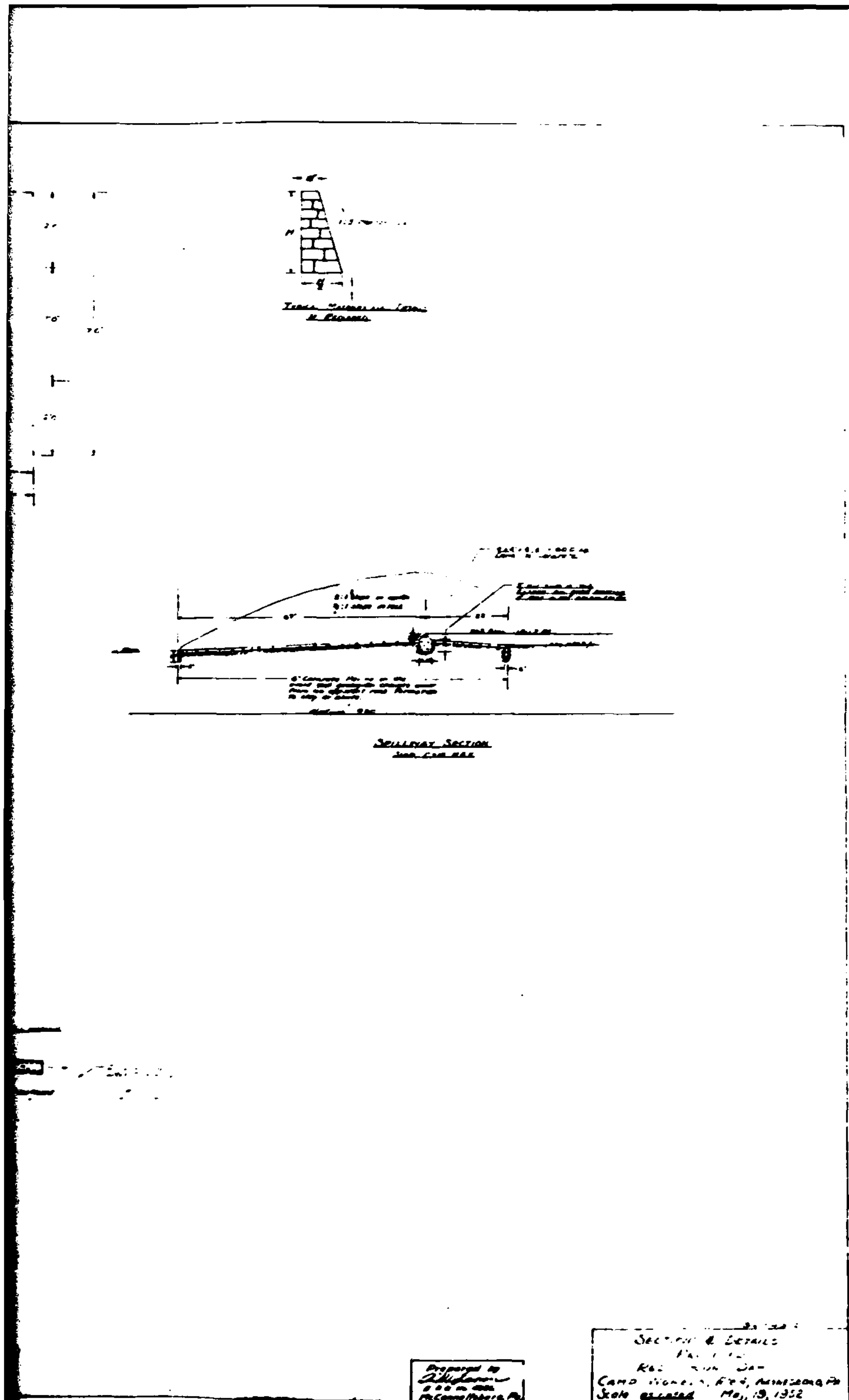


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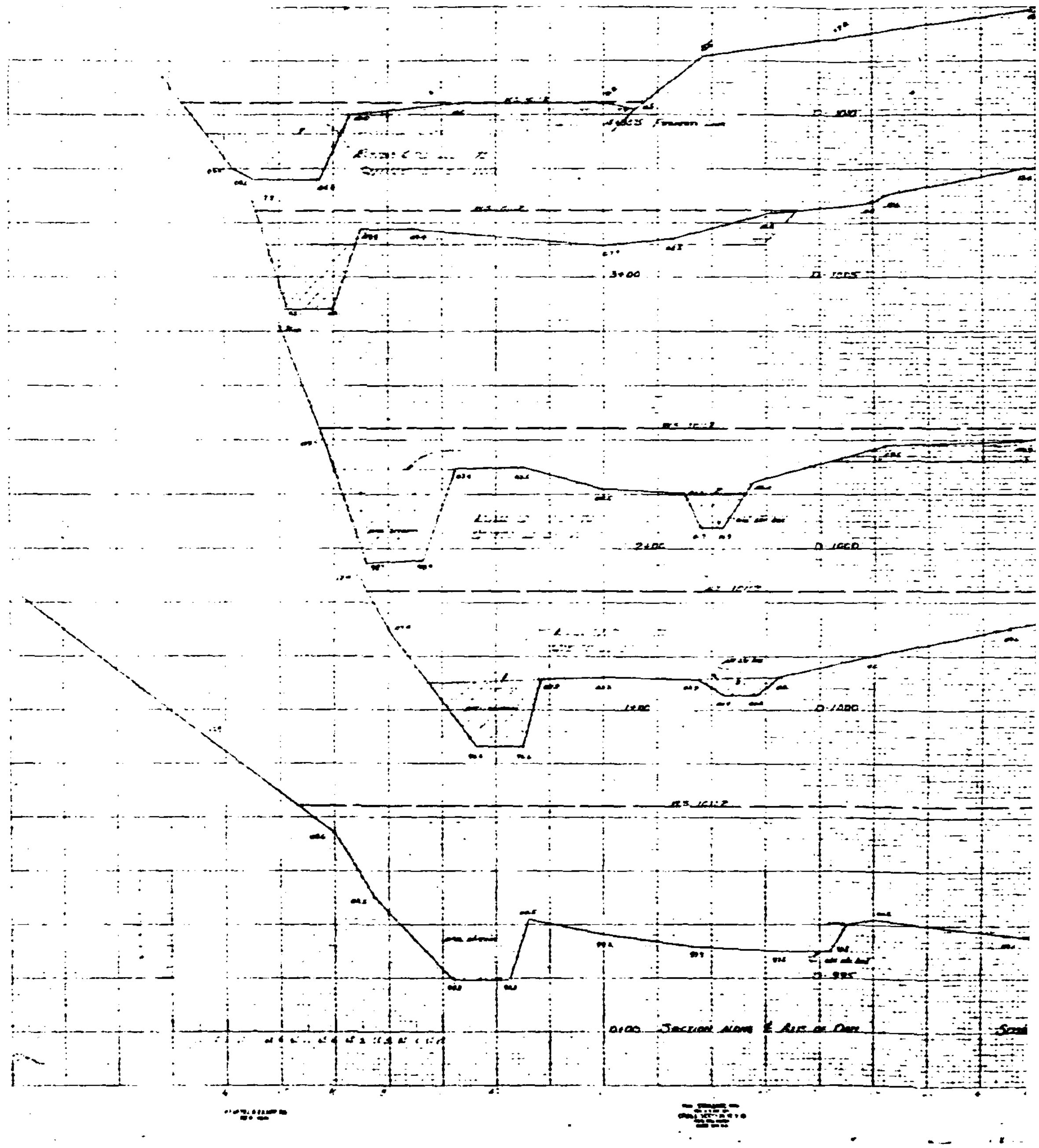
FIGURE 5



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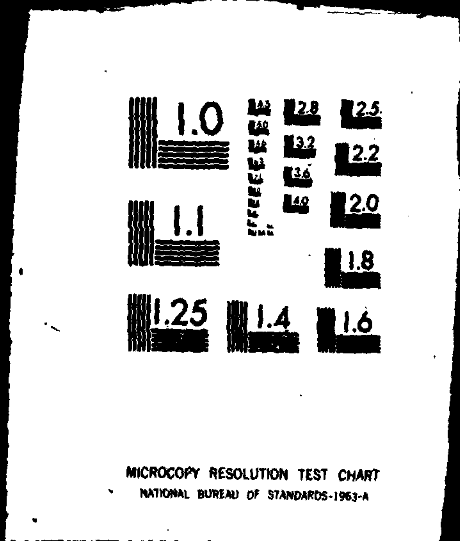

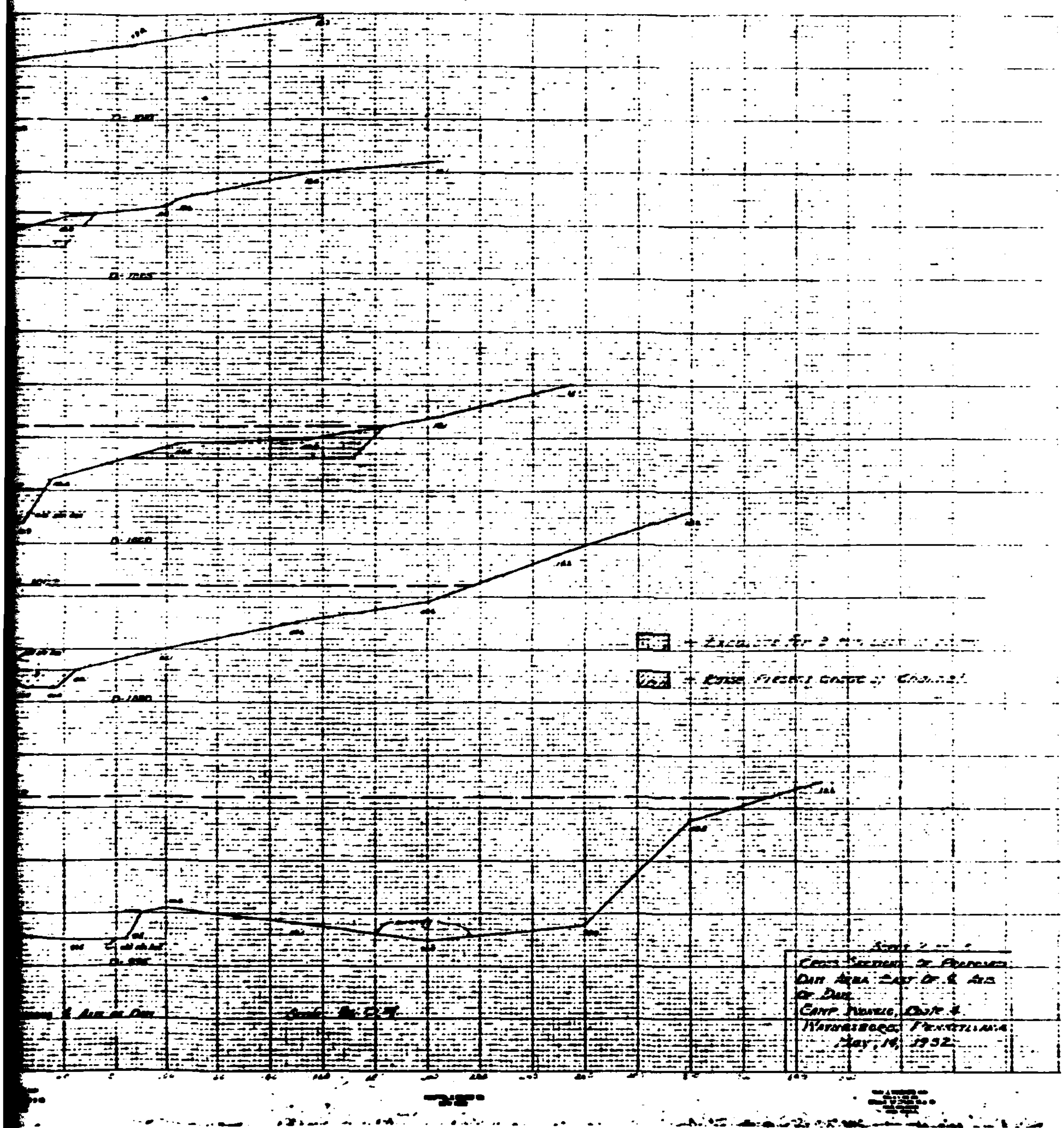

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FIGURE 6

APPENDIX F

GEOLOGY

Geology

Wohelo Lake Dam is located in the South Mountain section of the Blue Ridge physiographic province of southeastern Pennsylvania. This region is characterized by northeast trending ridges and valleys developed on alternating beds of volcanic and sedimentary rocks.

Bedrock immediately underlying the dam and reservoir is the Harpers Formation of Lower Cambrian age. The Harpers Formation is composed of a thick sequence of graywacke, siltstone, phyllite, and the conspicuous Montalto quartzite member. This very resistant quartzite forms the upper slopes and crests of the ridges, while the less resistant siltstones, phyllites, and graywackes underline shallow, longitudinal valleys.

Structurally, the dam and reservoir lie on the Massanutten syncline which is bounded on the east by the Antietam Cove fault, a sub-vertical and left lateral strike-slip fault, and on the west by the South Mountain Anticlinorium. The South Mountain Anticlinorium is defined on the west by steep westerly dips toward the Cambro-Ordivician carbonates, and on the east by a series of normal faults along the margin of the Triassic basin. The immediate area contains four anticlines, in some of which the pre-Cambrian rocks are exposed, and corresponding synclines, which enclose Cambrian siltstones and some limestones.

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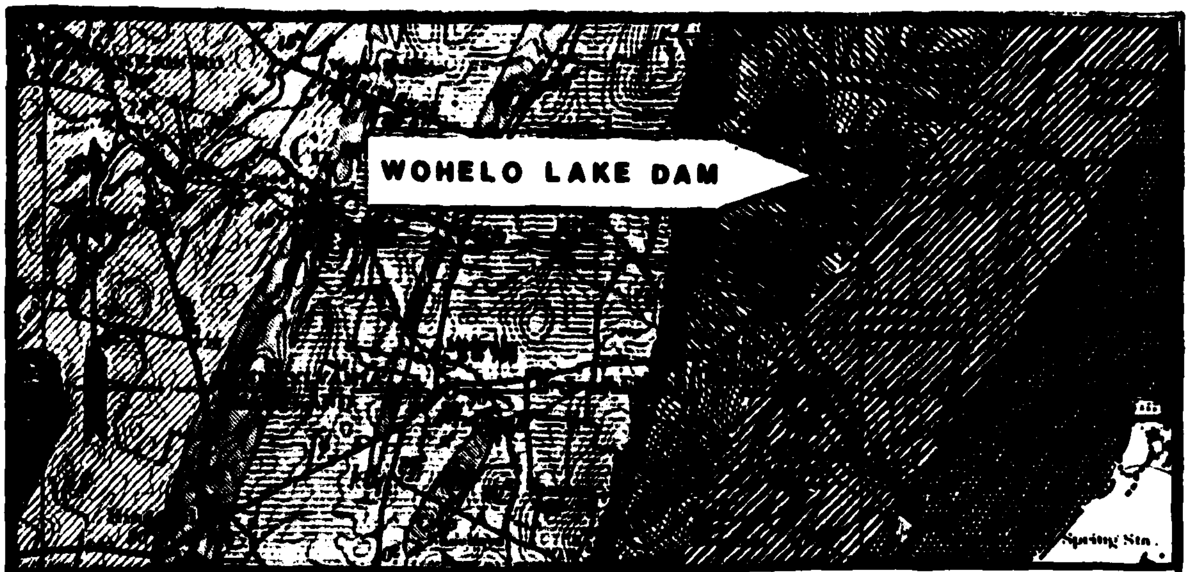

LEGEND

CAMBRIAN

Cc
Ccs

Conococheague limestone
(Hard siliceous banded limestone and calcareous sandstone with limestone pebbles. Ccs, sandstone and chert layers.)

Ce

Elbrook limestone
(Thinly laminated, fine-grained, argillaceous limestone; weathers to buff earthy limestone)

Cwb

Waynesboro formation
(Red shale and sandstone and some interbedded limestone)

£t

Tomstown dolomite
(Chiefly dark knotty dolomite; blue-banded pure limestone, in upper part, and thin intervening shale)

Ca

Antietam quartzite
(Gray to buff ferruginous quartzite; upper beds contain scanty fossil remains)

Ch

Harpers phyllite
(Gray phyllite and slate, banded with quartzose phyllite)

Weverton quartzite
(Cw, light gray to dark, purple banded, granular to vitreous quartzite and thick-bedded, purple, ferruginous quartzite; overlain by thick-bedded, hard vitreous white quartzite)

PRECAMBRIAN

Catoctin metabasalt
(Massive basaltic lava flows, composed of hornblende, albite, and epidote, with amygdular layers and secondary quartz-epidote masses; closely folded and altered to hornblende-chlorite schist in part; contains green tuffaceous schist not separated on map)

Scale

0 1 2 MILES

REFERENCE:
GEOLOGIC MAP OF WASHINGTON COUNTY PREPARED BY MARYLAND GEOLOGICAL SURVEY IN COOPERATION WITH U.S. GEOLOGICAL SURVEY, DATED 1941.

GEOLOGY MAP

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